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REPORT

DEADLY ALGORITHMS

Destructive Role of Artificial Intelligence in Gaza War

SİBEL DÜZ, MUHAMMED SEFA KOÇAKOĞLU

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SETA

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EXECUTIVE SUMMARY

Israel strengthens its military capacity in both defense and attacks by intensively using "artificial intelligence" (AI) technologies. Defense systems such as the Iron Dome employ AI-supported radars to automatically identify and neutralize missile threats, minimizing human intervention and improving operational efficiency. Similarly, AI-enhanced combat systems like Habsora and Lavender exclude human factor in target acquisition and planning of the attacks and provide autonomous functions. However, employment of those technologies in civilian areas increases civilian casualties and significant evidence are available in open sources about Israel's violation of international law during those military operations.

Israel intensively utilized AI technologies during wide-ranging attacks against Palestine, especially after October 7, 2023. Definition of civilian casualties in those operations as "collateral damage" and disregarding the civilian areas in target acquisition violate basic principles of international law of war. Ethical and legal aspects of Israel's attacks through AI-supported systems that harm civilians are criticized by human rights organizations and international community. Destructive impact of Israel's op-

erations utilizing those technologies on civilian population deepens human rights violations.

This report underlines the following:

- **AI-supported Military Systems:** Israel intensely benefits from AI technologies in defense and offense systems. Defense systems like the Iron Dome quickly detect and intercept threats, while AI-enhanced combat systems such as Habsora and Lavender autonomously execute target acquisition and strike process. These systems minimize human intervention in identification and elimination of threats and speed up operations.
- **Civilian Casualties:** Use of AI-based systems in assaults had serious consequences for civilian population in Palestine, particularly in Gaza. Targeting of civilians in the attacks violates principle of "distinction between civilian and military targets" cited in international law. Targets identified by AI were struck despite their proximity to civilian settlements and this caused massive civilian casualties. Civilian casualties in Israel's operations are regarded as "collateral damage" and this brings those violations to spotlight in terms of international law.
- **Violation of principles of proportionality and distinction:** Use of AI-supported systems in Israel's attacks on Palestine significantly violates proportionality and distinction, basic principles of law of war. These principles are designed to ensure theprotection of civilians in assaults on military targets and to maintain a balance between military necessity and civilian casualties. Whereas, Israel's operations overlook those principles and thus, cause an increase in civilian casualties.
- **Autonomous Systems in Target Acquisition:** AI systems such as Habsora and Lavender accelerates target acquisition processes and enable conducting operations with far less human intervention. Those systems analyze accumulated intelligence data and mark potential targets and the fact that whether targets are within civilian settlements or not, whether an attack would harm civilian infrastructure is disregarded. As a result, striking targets identified through these systems cause mass civilian casualties and violation of international law of war.
- **Systematic Violation of International Law:** Operations Israel carried out through AI-supported systems violate basic principles of law of

war. According to reports by United Nations (UN) and human rights organizations, Israel's attacks against civilians violate law of war and constitute war crimes. Direct targeting of civilian population and disproportionate use of force in military operations are assessed as acts against international law and analyzed as war crimes.

- **Technological Determinism and Responsibility:** Definitive role of technology in Israel's AI-supported military operations stirred up an in-depth debate on ethics and laws in terms of responsibility and accountability. The minimal human intervention in decision-making processes of autonomous AI systems obscures the question of who commits war crimes and who should be held responsible for them. Autonomous decision-making ability, particularly of systems such as Lavender and Habsora, complicate the chain of responsibility and bring up new challenges how those systems can be inspected in terms of human rights violations.

Israel's AI-supported military operations bring about a major change in modern warfare technologies, as well as major problems on ethics and international law. High civilian casualties lead to a debate on how responsibly those technologies are used in warfare. International community has to draft new regulations to regulate the use of AI-based weapons and for protection of civilians. Israel's attacks against civilians are at the center of ethical and legal debate in this field and underline the necessity of an update in international law.

INTRODUCTION

Israel is known as a country which massively developed and used AI technologies in defense and offense. Israeli Defense Forces (IDF) and defense industry integrate AI-supported systems and aim to reinforce effectiveness and efficiency in military operations. Use of AI and autonomous systems can be considered as a turning point in modern warfare technologies. Israel heavily invests in those technologies to gain a strategic advantage and increase the efficiency of its military operations. These systems bring a sweeping change to nature of the warfare and increase speed and accuracy of military processes by minimizing human intervention. However, devastating impact of those technologies on civilians stirs up a serious debate in terms of ethics and international law.

Iron Dome is one of the most familiar AI-supported systems of Israel. This defense system neutralizes majority of short-range rockets and mortars targeting Israel. AI reduces the need for human intervention by enabling automatic detection, assessment, and elimination of threats. Theanalysis of radar and sensor data by AI allows for rapid decision-making on which threats should be eliminated as a priority.

Besides defense systems, Israel deploys AI extensively in offensives. AI-supported decision support systems, particularly Habsora and Lavender plays a central role in target identification and planning of attacks. These systems analyze data from uncrewed aerial vehicles (UAVs), satellite imaging and other intelligence data to determine potential targets. Systems such as Harop loitering munitions system autonomously attack the target with the support of AI. Harop's ability to reassess the target prior to the attack prevents faulty targeting. Such autonomous weapons cause problems such as disregard for civilian casualties and the automatic targeting.

Another field where Israel developed AI technology is cyber defense and offensive systems. AI plays a critical role in preemptive detection of cyber-attacks, assessment and automation of defense mechanisms. AI-supported anomaly detection systems monitor abnormal activity in networks in real time and can identify attempted attacks. Moreover, AI-based cyberattacks can identify weaknesses of targeted systems and contain autonomous combatsoftware exploiting those weaknesses.

Israel has been deploying majority of those AI systems in attacks against Palestine especially after October 7 and minimizing human intervention in those processes. Systems such as Lavender overlook civilian-populated areas while identifying targets. Targets automatically marked by AI are struck without consideration of international law and this causes high civilian casualties. In this process, civilian casualties are viewed as "collateral damage" by Israel and attacks are carried out despite calculation of possible civilian casualties between 20 to 100 people in any given attack. In conclusion, Israel's attacks through employment of AI technologies brought about many military innovations but they led to major problems with regard to war ethics and international law.

MODERN WARFARE AND MILITARY USE OF AI

AI swiftly progressed thanks to development of AlexNet in 2012 and AlphaGo in 2016 and improvement of transistor technology. As with the emergence and development of many pioneering technologies, AI is advancing in parallel and alongside the evolution of security and military systems. Rapidly developing AI, in this context, led to a landmark transformation in military strategy and warfare technologies and is reshaping the nature of modern warfare. Options provided by AI are integrated in every phase of military operations as remote warfare and unmanned warfare prevail. Autonomous weapons systems, unmanned vehicles, surveillance and intelligence systems and cyber warfare technologies are among most significant components where AI shaped modern warfare. Obviously, AI race stimulates competition between major states and private companies and this competition also manifests itself in armament strategies of states.

Studies are underway in various fields for integration of AI in numerous systems. The research ranges from most basic

missile guidance algorithms to decision systems analyzing an entire conflict zone. The most significant military use of AI, however, is autonomous weapons systems. These systems can carry out critical missions such as target acquisition and elimination, without human intervention, and deployment of AI-supported systems in decision-making processes in the battlefield is increasing. Deployment of fully autonomous systems entirely depending on AI decisions is not confirmed officially but this is technically possible and it is known that certain countries are developing it. Countries including US, China and Russia invest heavily in this field and allocate budgets for this purpose. Strategic position of US and China is a testament to this fact: 2024 National Defense Authorization Act (NDAA) passed by the Congress and approved by President Joe Biden on December 22, 2023 earmarked $886 billion for 2024 defense budget of the United States.[1] Reference in the Act to a 43-page report entitled "Artificial Intelligence and National Security" prepared by Congressional Research Service and last updated in 2020 is highly significant.[2]

Researchers of Chinese People's Liberation Army (PLA) also conducts comprehensive research on security and weapons systems.[3] In this context, significant research is underway in several fields from missile systems to electronic warfare.

Another significant advantage that AI offers in warfare is the revolutionary transformation in data analytics and intelligence gathering processes. AI analyses big datasets and accelerates threat detection and minimizes human error in these processes. However, deployment of these technologies in warfare is not exclusive to real-world conflict zones and it is also applied in cyber warfare, social media, propaganda and disinformation/malinformation.

Deployment of AI in warzone and studies in this field is included in projects of major companies. "Project Maven" launched by US Department of Defense in 2017 which aims to integrate AI in military operations aims

1 "Statement from President Joe Biden on H.R. 2670, National Defense Authorization Act for Fiscal Year 2024", White House, December 22 2023, https://www.whitehouse.gov/briefing-room/statements-releases/2023/12/22/statement-from-president-joe-biden-on-h-r-2670-national-defense-authorization-act-for-fiscal-year-2024, (Date of Access: August 30 2024).

2 "Artificial Intelligence and National Security", Congressional Research Service, November 10 2020, https://crsreports.congress.gov/product/pdf/R/R45178, (Date of Access: August 30 2024).

3 Ma Xiu, "The PRC State & Defense Laboratory System Part Two: Defense S&T Key Lab Directory", BluePath Labs for China Aerospace Studies Institute, March 20 2023.

fast and efficient analysis of large image data particularly supplied by UAVs.[4] AI algorithms scan the images and detect suspicious activities and objects and thus aims to accelerate decision-making processes of security forces. This project received significant support from Google. Google employees openly protested working on the project in 2018. Although Google claims it assists in automatic analysis of images taken by UAVs, employees penned an open letter to CEO Sundar Pichai to tell him that Google should not be in the business of war.[5]

The U.S. conducts drone strikesusing AI-driven methods based on algorithms and big data analysis to eliminate targets listed in so-called "kill lists". For instance, as part of signature strikes, people fitting with suspicious behavior patterns are directly targeted in countries like Pakistan and Yemen. Yet, civilian deaths stemming from shortcomings in accurate data constitute a major risk in this approach.

Remote warfare has advantages and disadvantages. Reduced human control particularly in deployment of autonomous systems leads to important problems in terms of war ethics and damage to civilians. Monitoring civilian casualties and their prevention pose a major challenge. In addition, inadequacy of democratic oversight mechanisms on such operations reduces public engagement in war and undermines transparency. These methods are expected to provide a swift solution but it should not be disregarded that they also create significant ethical concerns such as human rights violations and lack of accountability.

4 Saleha Mohsin, "Inside Project Maven: The US Military's AI Project", Bloomberg, March 1 2024, https://www.bloomberg.com/news/newsletters/2024-02-29/inside-project-maven-the-us-military-s-ai-project, (Date of Access: October 30 2024).

5 "Google 'to End' Pentagon Artificial Intelligence Project", BBC News, June 2 2018.

ISRAEL'S AI-BASED DEFENSE AND SURVEILLANCE SYSTEMS

AIR DEFENSE SYSTEM

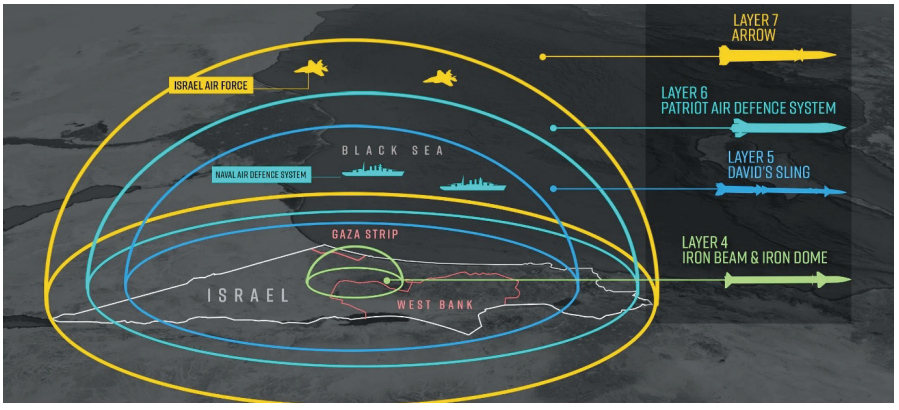
Israel has developed a multi-layered defense architecture based on advanced technology as a country attaching great importance to air defense and security. Those systems provide protection against short, medium and long-range missile threats. Iron Dome, one of the most critical components of this structure is basically designed to prevent medium and short-range missile threats. Through AI-supported radars, this system detects missiles, prioritizes those posing a threat and intercept them mid-air.[6] Iron Dome is a part of Israel's multi-layered defense structure and this architecture is composed of linked

6 Ian Slesinger, "A Strange Sky: Security Atmospheres and the Technological Management of Geopolitical Conflict in the Case of Israel's Iron Dome", *Wiley, The Geographical Journal*, Volume: 188, Issue: 3, (2022), p. 429-443.

layers that communicates with many subcomponents and systems along with other components.[7]

Systems like David's Sling, Terminal High Altitude Area Defense (THAAD),[8] Patriot Advanced Capability-3 (PAC-3)[9] and Arrow 3[10] which are included in Israel's air defense systems, have their own multi-layered structures as well. This defense architecture is developed for efficient protection against different levels of threat. These systems work in integration with sensors and command control centers to manage the processes from detection of threats to their elimination in a comprehensive way. Thus, Israel strives to constantly protect its airspace against short and long-range missile attacks.

Figure 1. Israel's Multi-layered Air Defense System Architecture



Source: The Print.com

Iron Dome system can detect launched missiles thanks to its advanced radars and assess the threat levels of those missiles. The radar system instantly tracks launched missiles and observes their speed and direction. Subsequently, command control system is activated and analyze the landing point of the

7 Khoerozadi Faizal Iman, Robertus Heru Triharjanto, Heri Budi Wibowo and Yayat Ruyat, "Comparative Analysis of a Multi-Layered Weapon System for City Air Defense in the Modern Warfare", *International Journal of Humanities Education and Social Sciences*, Volume: 3, Issue: 3, (December 2023).

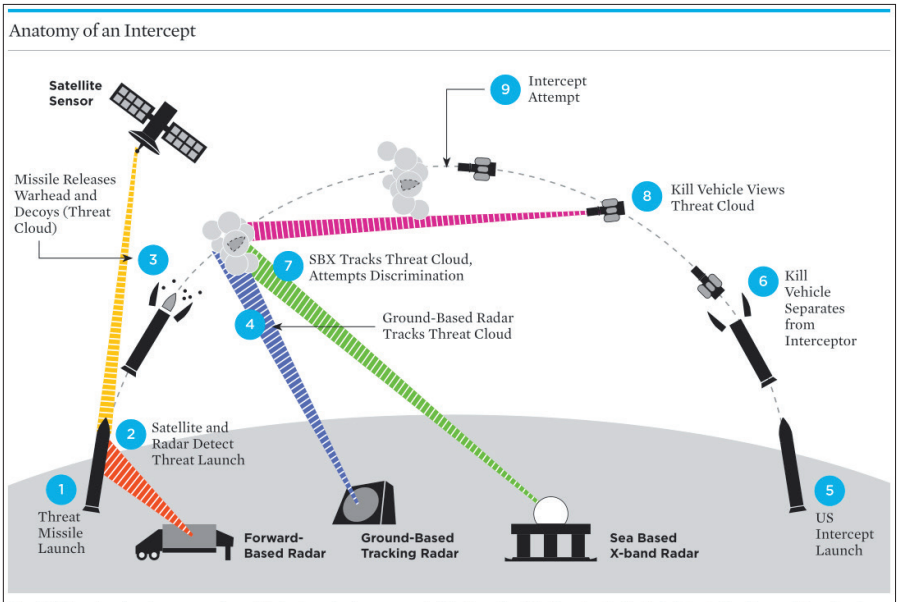
8 Brad Lendon, "What is THAAD? The Powerful US Anti-Missile Defense System is Being Sent to Israel – Along with up to 100 Supporting Troops", CNN, October 14 2024.

9 "Patriot Advanced Capability-3 (PAC-3)", Director Operational Test and Evaluation Report, *October* 30 2024, https://www.dote.osd.mil/Portals/97/pub/reports/FY2012/army/2012patriot.pdf?ver=2019-08-22-111732-957, (Date of Access: August 30 2024).

10 "What are Israel's Iron Dome and Arrow Missile Defenses?", Reuters, October 26 2024.

missile, calculating proximity of this point to residential areas or important infrastructure facilities. If the impact point poses a danger, fixed or mobile units tied to Iron Dome system launch an interceptor missile. This interceptor missile engages the incoming missile and destroys it mid-air. Thus, a missile posing a threat is eliminated before reaching its target. Iron Dome destroys only the missiles posing a genuine threat and strives to prevent unnecessary use of munitions.[11] But low-cost, "homemade" rockets of groups like Hamas can occasionally challenge this expensive defense system and inflict damage or casualties.[12]

Figure 2. Basic Interception of Targeted Missile by an Air Defense System


Anatomy of an Intercept
Satellite Sensor
9 Intercept Attempt
Missile Releases Warhead and Decoys (Threat Cloud)
8 Kill Vehicle Views Threat Cloud
3
7 SBX Tracks Threat Cloud, Attempts Discrimination
6 Kill Vehicle Separates from Interceptor
4
Ground-Based Radar Tracks Threat Cloud
2 Satellite and Radar Detect Threat Launch
1 Threat Missile Launch
Forward-Based Radar
Ground-Based Tracking Radar
Sea Based X-band Radar
5 US Intercept Launch
© Union of Concerned Scientists

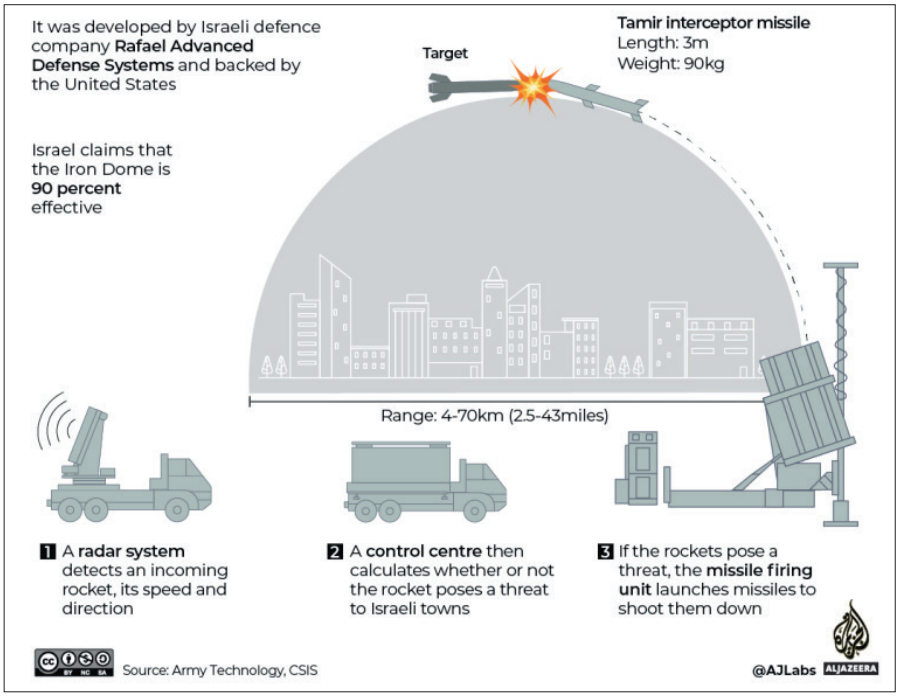
The GMD system involves a complex, global network of components. The launch of the threat missile (1) is detected by forward-based radars, if present, and satellite-based infrared sensors (2). The threat missile releases its warhead and decoys (in this example the decoys are balloons, and a balloon contains the warhead; together they are referred to as the "threat cloud") (3), and the ground-based radar begins tracking the threat cloud (4). Based on information from this radar, the GMD system launches one or more interceptors (5), each of which releases a kill vehicle (6). If a discrimination radar, such as the Sea Based X-band Radar, is in place it will observe the threat cloud to try to determine which object is the warhead (7) and pass this information to the kill vehicle. The kill vehicle also observes the threat cloud to attempt to determine which object is the warhead (8). It then steers itself into the path of the chosen object and attempts to destroy it with the force of impact (9).

Source: "Missile Defense Systems at a Glance", Arms Control Association, (August 2019), https://www.armscontrol.org/factsheets/missile-defense-systems-glance, (Date of Access: November 20 2024).

11 "What are Israel's Iron Dome, David's Sling, Arrow and Thaad Missile Defences?", BBC News, October 16 2024.

12 Bala Chambers, "Is Hamas's Military Arsenal Any Match for the Israeli Defence Complex?", TRT World, October 10 2023.

Figure 3. Basic Structure of Iron Dome


It was developed by Israeli defence company **Rafael Advanced Defense Systems** and backed by the United States
Israel claims that the Iron Dome is **90 percent** effective
Target
Tamir interceptor missile
Length: 3m
Weight: 90kg
Range: 4-70km (2.5-43miles)
1 A **radar system** detects an incoming rocket, its speed and direction
2 A **control centre** then calculates whether or not the rocket poses a threat to Israeli towns
3 If the rockets pose a threat, the **missile firing unit** launches missiles to shoot them down
Source: Army Technology, CSIS
@AJLabs
ALJAZEERA

Source: CSIS

AI plays a critical role in efficient operation of Iron Dome. Its integration into the system, enables automation of target acquisition, prioritization and intervention processes.[13] AI's functions in this system can be divided as following:

Radar and Sensor Systems

Iron Dome is equipped with radar and sensor systems. These systems enable the detection, tracking, andlocating of hostile missiles. AI analyzes this data and defines which threats should be prioritized and make decisions on which missiles will be eliminated. This process is technically possible on radar and sensor systems. In other words, the system can make identification without direct human intervention. This process prevents deployment of unnecessary munitions. In addition, apart from sensors, AI is used as a deci-

13 Patricio Páliz, Acosta Juan, Tiuma Alexis and Bravo Marlon, "Avances en Sistemas de Defensa Antiaérea", *Athenea Engineering Sciences Journal*, Volume: 3, Issue: 9, (2023), p. 15-25.

sion support system and open to user interpretation.[14] (The structure here is different than decision support and is directly undertaken by radars and sensors.) Technically, radar parameters and analyses are supported by AI.[15] Yet, the level of support here or to what extent AI supported mathematical, technical and engineering calculations of radars and sensors is unknown. For this reason, although AI support is confirmed, its exact architecture and level is unknown.

Satellite-based surveillance systems and land-based radars enable early detection of missiles and helps AI to process these data more efficiently.

Decision Support Systems

AI also assists decision support systems. The system automatically determines which missiles will be eliminated based on type, range and potential impact of incoming threats. Moreover, decision makers can be semi-autonomously authorized. This is determined by the system and authorities in the command control center.

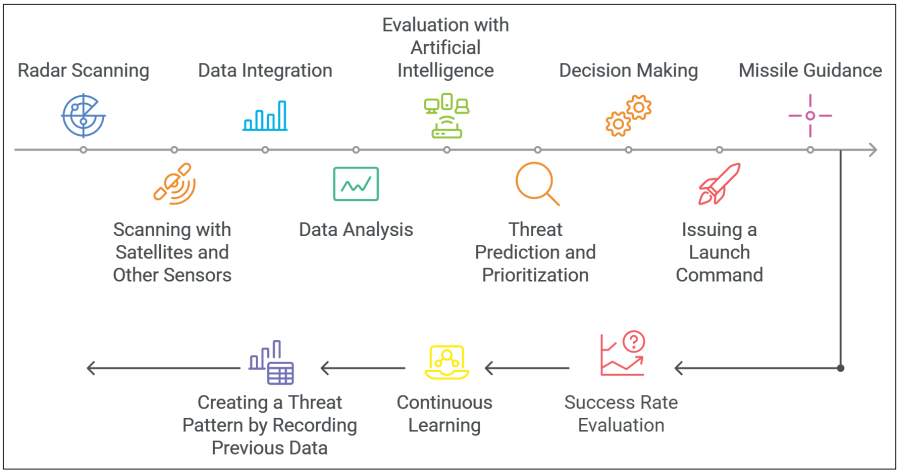
Missile Defense Systems

Iron Dome activates counter-missile systems to detect and intercept threatening missiles. In this process, AI enhances this process by determining the optimal interceptionpoint and selecting the most suitable counter-missile, thereby increasing the efficiency of the system. This enhances targeting accuracy and minimizes the possibility of striking incorrect targets.

14 Tal Mimran, Magda Pacholska, Gal Dahan and Lena Trabucco, "Israel-Hamas 2024 Symposium-Beyond the Headlines: Combat Deployment of Military AI-Based Systems by the IDF", Lieber Institute West Point | Articles of War, February 2 2024, https://lieber.westpoint.edu/beyond-headlines-combat-deployment-military-ai-based-systems-idf/, (Date of Access: October 30 2024).

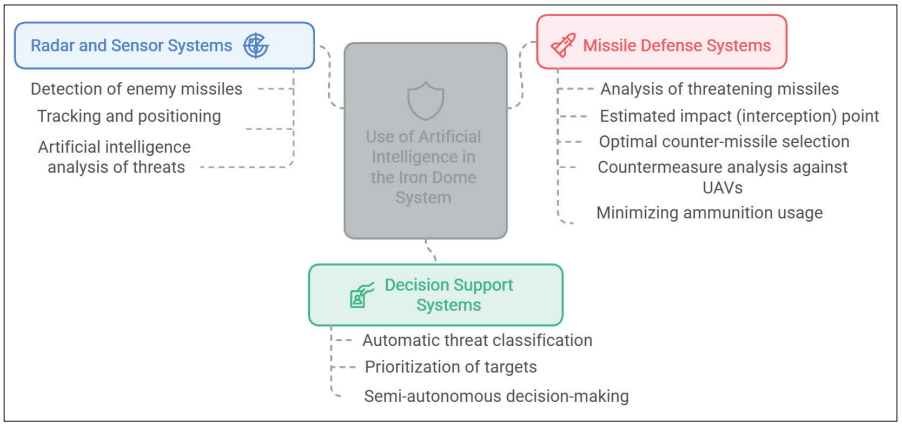
15 Lauren Irwin, "How does Israel's Iron Dome Work?", *The Hill*, January 10 2024.

Figure 4. Operation Process of Iron Dome



Source: Compiled by authors.

Figure 5. AI Use in Iron Dome



Source: Compiled by authors.

Through constantly updated algorithms, AI provides an effective defense against low-altitude threats – especially new types of threats like UAVs. But it is unknown to what extent Israel used AI in these systems. Measures can be created against future attacks by collecting numerous data including analysis of previous attacks, determination of missile launch points, coordinates where they penetrated into air defense system and launching process of interceptor missile but reporting level of those analyses is unclear.

This system, which incorporates AI and limited internet accessibility, has been known to exhibit security vulnerabilities in the past. The most striking

example of this that was made public recently is the fact that the system could not prevent missile attacks after a Palestinian engineer attacked the system and made it passive between 2015 and 2016.[16] Despite occasional reports of system malfunctions, [17] its success rate remains significantlyhigh.[18]

Hamas launched a barrage of missile attacks on October 7, 2023 and its aftermath. Those attacks carried out by more than 5,000 missiles on October 7 left a significant impact.[19] Israel's Iron Dome defense system managed to neutralize majority of those attacks and exhibited a strategic defense accomplishment. However, Hamas' missile capacity greatly weakened after Israel's intense counterattacks on Gaza. Since the end of that October, number of attacks and amount of missiles Hamas used in those attacks significantly decreased. For example, limited attacks carried out by only 8 missiles on May 26, 2024 and two missiles in August 2024.[20]

Israeli airspace is also threatened by Hezbollah, Houthis in Yemen (Ansarullah) and Iran in addition to Hamas. Tensions escalated after Hezbollah's missile attacks and gunfire in Shebaa Farms on October 8, 2023 and they prevailed amid attacks by both sides.[21] Since October 7, 2023 to this day, Israel and Hezbollah carried out more than 4,400 missile attacks and other types of attacks.[22]

On April 13, 2024, Iran carried out missile and loitering munitions attacks against Israel in its "Operation True Promise".[23] News agencies re-

16 There have been numerous reports in the media stating that the Palestinian engineer responsible for the attack was abducted by Mossad but later brought to Istanbul through an operation conducted by the Malaysian police and the Turkish National Intelligence Organization in Malaysia.
See "He broke down Iron Dome, MOSSAD came after him! MIT operation to save young Gazan genius", *Milliyet*, November 22, 2023.

17 Ahmet Dursun, "Israel questions efficiency of Iron Dome Air Defense", Anadolu Agency, May 5 2023.

18 Josh K. Elliott, "Israel's Iron Dome: How the Defence System Works, and Why It's under Strain", Global News, April 15 2024, https://globalnews.ca/news/1203882/israels-mobile-missile-defence-system-what-is-the-iron-dome, (Date of Access: August 29 2024).

19 Kubovich, Yaniv, "The First Hours of the Israel-Hamas War: What Actually Took Place?", *Haaretz*, October 17 2023.

20 "Hamas Fires Rockets Toward Central Israel, Israel Dampens Hezbollah Attack", *The Jerusalem Post*, August 25 2024.

21 "Israel, Hezbollah Exchange Fire, Raising Regional Tensions", Aljazeera, October 8 2023.

22 Seth G. Jones, Daniel Byman, Alexander Palmer and Riley McCabe, "The Coming Conflict with Hezbollah", Center for Strategic and International Studies (CSIS), March 21 2024, https://www.csis.org/analysis/coming-conflict-hezbollah, (Date of Access: October 31 2024).

23 "Israel Getting Punished with Operation True Promise", *Tehran Times*, April 14 2024.

ported that number of missiles launched in those attacks ranged between 200 and 300.[24] IDF spokesperson said about 350 missiles launched from Iran, Iraq, Lebanon and Yemen towards Israel.[25]

Israel successfully prevented incoming missiles by deploying Arrow 3 and David's Sling[26] systems. In addition, it resorted to electronic jamming techniques to deactivate missiles' navigation systems.[27] Many UAVs flying in Syrian airspace were shot down.[28] Israeli officials said they successfully neutralized 99 percent of weapons posing a threat; in addition, they reported that the air force seized 25 cruise missiles outside the borders, likely in Jordanian airspace.[29]

Israel's air defense systems have been successful. After the attacks, Israel carried out retaliatory attacks against targets in Lebanon and Hezbollah targets.[30] Attacks led to killing of Hezbollah Secretary-General Hassan Nasrallah on September 27, 2024.[31] Attacks continued with retaliatory strikes by both sides. Iran carried out more than 100 missile attacks against Israel on October 1, 2024, in at least two waves.[32] Nevatim airbase in Negev sustained the highest damage in the attacks. This base hit by 20 to 32 missiles.[33] Tel Nof airbase was also hit by sustained less damage.[34] Perimeter of headquarters of Mossad

24 Brad Lendon, "How Israel and Allied Defenses Intercepted More Than 300 Iranian Missiles and Drones", CNN, April 14 2024.

25 "April 14, 2024 - Iran's Attack on Israel", CNN, April 14 2024.

26 "להצ סיסבל לק קזנ ,וטרוי בורה :זאריאמ מייטסילב מיליטו מימ"בטכ תפקתמ", Calcalist, https://www.calcalist.co.il/local_news/article/hygslvog0, (Date of Access: August 30 2024).

27 Brian Barrett, "How Israel Defended Against Iran's Drone and Missile Attack", Wired, April 14 2024, https://www.wired.com/story/iran-israel-drone-attack-iron-dome, (Date of Access: October 31 2024).

28 Suleiman Khalidi, "Most Iranian Drones over Syria were Downed by Israel, U.S. Intelligence Sources Say", Reuters, April 14 2024.

29 Ken Klippenstein and Daniel Boguslaw, "U.S., Not Israel, Shot Down Most Iran Drones and Missiles", Reuters, April 15 2024.

30 "IDF Jets Strike Military Structures in Southern Lebanon Belonging to Hezbollah's Radwan Forces", *The Jerusalem Post*, April 14 2024.

31 Bassem Mroue, "Israel Strikes Hezbollah in a Huge Blast Targeting the Militant Group's Leader", AP News, September 28 2024

32 "US Defence Secretary Tells Israeli Counterpart Iran Attack an 'Outrageous Act of Aggression' – as It Happened", *The Guardian*, October 2 2024.

33 Andrew Roth, "Escalation with Iran could Be Risky: Israel is More Vulnerable Than It Seems", *The Guardian*, October 5 2024.

34 "Iran Releases Video Simulating Missile Attack on Israel", *The Washington Post*, October 4 2024.

and signal intelligence service Unit 8200 was also hit.[35] Iran claimed striking 90 percent of its targets.[36] Satellite images show high level of damage.

In conclusion, Israel's air defense systems went through a critical exam in the face of intense missile and UAV attacks recently. Particularly attacks carried out by Iran on October 1, 2024 which involved more than 100 missiles inflicted significant damage on strategic locations like Nevatim and Tel Nof airbases. Targeting of Mossad and Unit 8200 headquarters also revealed the scale and diversity of security threats. This led to questioning the efficiency of existing air defense systems. Israel is making deals to enhance its air defense capacity.[37]

AI USE IN SURVEILLANCE AND RECONNAISSANCE SYSTEMS

Camera and Surveillance Systems

Surveillance technologies Israel used in occupied Palestinian areas such as Gaza and West Bank largely depends on AI and biometric systems. These technologies which work on a large data collection network, facial recognition systems and big data analysis tools are designed for constant monitoring of movement of Palestinians in the region. Through a large number of cameras and sensors it set up in the region, Israel created massive databases and prior to October 7, 2023, it turned Gaza and a large part of Palestine into a digital prison where it ran surveillance.

Wolf Pack, Red Wolf and Blue Wolf Systems

Red Wolf and Blue Wolf systems employed by Israel scan the face of Palestinians at military checkpoints and search for matches in databases. These systems are used both for verification of identity and limit the movements of the people. AI-supported facial recognition systems like Red Wolf expanded their database by accumulation biometric information of more Palestinians

35 "Approximately 100 Houses in Hod Hasharon Damaged by Iranian Missile Attack – Report", *The Jerusalem Post*, April 14 2024.

36 "Iran Claims 90% of Its Missiles Hit Their Targets in Israel", *The Times of Israel*, October 1 2024.

37 "US Says THAAD Anti-Missile System is 'in Place' in Israel", Reuters, October 21 2024.

over time. This surveillance network first introduced systematically by Israel in 2000, significantly grew by 2024.

Amnesty International explained in detail in its reports how Israel's facial recognition cameras violated human rights of Palestinians in the West Bank and how they spread Israel's apartheid system.[38] Relevant reports highlighted this was a serious issue after October 7 with those statements:

> "This is particularly urgent in the wake of Israel's escalating surveillance-enabled crackdown on freedom of movement and freedom of association and peaceful assembly. Supplying hardware or software that can be used to reinforce apartheid, which is a crime against humanity, and other human rights violations by Israel against Palestinians must not be tolerated under any circumstance."[39]

Israel deploys a system called Wolf Pack as part of a series of military surveillance initiatives. This system is a massive database for comprehensive surveillance of Palestinians.[40] This system contains details including photographs, family information and security ratings particularly for Palestinians in the West Bank. The system is developed as an extension of Israel's policies of surveillance and control in the West Bank, and over time, was integrated with other surveillance technologies such as Blue Wolf and Red Wolf.

Wolf Pack is general name of a database system. Blue Wolf which was initiated in 2016 is employed by Israeli military forces and police.[41] This system involves taking photos of Palestinians and saving them to a database. Palestinians stopped at checkpoints are instructed to stand before a smartphone or CCTV camera and supply information about themselves and then, operation room has access to this information through Wolf Pack system. Usually, when a security officer takes photo of an individual, the application

38 "Israel and Occupied Palestinian Territories: Automated Apartheid: How Facial Recognition Fragments, Segregates, and Controls Palestinians in the OPT", Amnesty International, May 2 2023, https://www.amnesty.org/en/documents/mde15/6701/2023/en, (Date of Access: August 30 2024).

39 "Israel/OPT: Human Rights Safeguards Needed on Surveillance Technology Used Against Palestinians", Amnesty International, July 4 2023, https://amnesty.ca/human-rights-news/israel-opt-human-rights-safeguards-surveillance-technology-against-palestinians, (Date of Access: August 30 2024).

40 Aaron Boxerman, "Israel Reportedly Employing Large-Scale Surveillance Program to Monitor Palestinians in West Bank", Stars and Stripes, November 8 2021, https://www.stripes.com/theaters/middle_east/2021-11-08/israel-surveillance-palestinians-west-bank-facial-recognition-program-3541335.html, (Date of Access: August 30 2024).

41 Mustafa Abu Sneineh, "Meet Blue Wolf, the App Israel Uses to Spy on Palestinians in the Occupied West Bank", Middle East Eye, November 9 2021.

saves a match for an existing profile in Blue Wolf system.[42] The application then emits yellow, red or green lights to notify that said person should be allowed to pass, detained or to be immediately arrested.[43] It is claimed that Red Wolf system is an upgrade through more development of those systems. When a Palestinian cross a checkpoint where the Red Wolf is active, his/her face is scanned without his/her permission or knowledge and searched on database for other biometric entries. It shares a warning with immediate personnel, as Blue Wolf does, and runs constant surveillance analysis on people in the region. Israel is running a comprehensive surveillance operation with numerous systems and AI support.

Oron Surveillance and Reconnaissance Aircraft

Israeli Defense Ministry announced in 2021 that it had Oron, a multi-tasking spy plane in commission.[44] Oron, which is viewed as one of the most advanced of its kind, was developed by Israel Aerospace Industries (IAI). This project was conducted in cooperation with Directorate of Defense, Research, & Development (DDR&D) of Israeli Defense Ministry, Israeli Air Force (IAF), Intelligence Directorate and Israeli Navy.[45] The aircraft is designed through configuration and modernization of Gulfstream G550 business jet and can fly a high altitude and long range while its most significant feature is advanced sensors supported by AI and ability to monitor air and land targets simultaneously.[46] Oron retains advanced data processing systems that can run real-time analysis of collected data. These systems combine data supplied by AI-supported sensors and generate AI-based analysis. It is known that the first aircraft was delivered and engaged in operations. IAF deploys Oron particularly in missions involving surveillance of sensitive sites and detect

42 Sneineh, "Meet Blue Wolf, the App Israel Uses to Spy on Palestinians in the Occupied West Bank".

43 "Israel/OPT: Human Rights Safeguards Needed on Surveillance Technology Used Against Palestinians".

44 "The Israeli Air Force Officially Introduces the 'Oron,' a Highly Modified G550 with Unprecedented ISR Capabilities", The Aviationist, April 4 2021, https://theaviationist.com/2021/04/04/the-israeli-air-force-officially-introduces-the-oron-a-highly-modified-g550-with-unprecedented-isr-capabilities, (Date of Access: August 30 2024).

45 Anıl Şahin, "Israeli Air Force Launched New Oron Intelligence Aircraft", Defence Turk, April 12, 2021, https://www.defenceturk.net/israil-hava-kuvvetleri-yeni-oron-istihbarat-ucagini-tanitti, (Date of Access: August 29 2024).

46 "Israel/OPT: Human Rights Safeguards Needed on Surveillance Technology Used Against Palestinians".

enemy activities. It is known that Israel used it actively after October 7. The platform is used particularly prior to Israel's land offensive against Gaza and prior to attacks on Hezbollah targets on October 15, 2023.[47]

It is estimated that Israel also deployed AI in many other reconnaissance and surveillance systems. In addition, databases created with the assistance of those surveillance systems serve as basis of AI-supported decision support systems used for targeting and assassination.

47 Stefano D'Urso, "Israel Strikes Hezbollah Infrastructure as IAF G550 Nachshon Oron Patrols off Lebanon", The Aviationist, 16 Ekim 2023, https://theaviationist.com/2023/10/16/israel-strikes-hezbollah-infrastructure-as-iaf-g550-nachshon-oron-patrols-off-lebanon, (Date of Access: August 29 2024).

ISRAEL'S AI-BASED OFFENSIVE SYSTEMS

DECISION SUPPORT SYSTEM

The Israeli military deploys AI systems such as Lavender and Habsora to generate target lists, with reports indicating that this process involves minimal human intervention. These systems analyze majority of Palestinians in Gaza, identify potential Hamas or Palestinian Islamic Jihad members and automatically mark the targets. It is alleged that when a target is identified by AI, the Israeli military strikes it regardless of its location, nearby residential areas, or whether it is a building such as schools or hospitals whose targeting would constitute a war crime.

The Gospel (Habsora)

Israel used AI for target acquisition first in 2021: "The Gospel" system, which is known Habsora (הרושב) in Hebrew, tapped AI for Israel's attacks on Gaza and in brief clashes according to

claims. These claims are defined as inaugural use of AI in warfare and made the headlines such as "AI War".[48]

Roots of Habsora can be traced back to announcement by the Israeli government in 2019 on establishment of a targeting directorate to generate targets for IDF and IAF in particular.[49] IAF would run out of targets after striking all known targets in weeks of attacks and be unable to find Hamas members. Targeting directorate aimed to close this gap by preemptively creating a database including targets. Thus, "high-valued targets list" was identified in a digital database with a detailed analysis. This directorate comprised of hundreds of soldiers and analysts marked targets by collecting data from various sources. These sources include satellite and UAV images, communications data obtained via signal intelligence, surveillance and image intelligence data, open-source information, social media posts of the Hamas members and social media intelligence data acquired in a similar way. In addition, movements and behaviors of both individuals and large groups are being analyzed in detail.

Initial reports emerging after installation of system and database by media and IDF sources say targeting directorate utilized AI to process the data it collected and subsequently to determine targets faster than human analysts.[50]

It is claimed that Habsora is not only involved in targeting but also information about possible civilian casualties in advance.[51] Even though IDF says "a full match" between Habsora and a human analyst in targeting recommendation, interviews with AI operators revealed to what extent this was achieved after October 7.

Technically, "target generation" can be a simple concept but it is actually a very complicated task. One of the challenges is that it contains a myriad

48 Elisabeth Braw, "Israel's Targeting AI: How Capable is It?", RUSI, February 8 2023, https://www.rusi.org/explore-our-research/publications/commentary/israels-targeting-ai-how-capable-it, (Date of Access: August 29 2024).

49 "Israel's Targeting AI: How Capable is It?", WiredGov, February 9 2024, https://wired-gov.net/wg/news.nsf/print/Israels+Targeting+AI+How+Capable+is+It+09022024142500, (Date of Access: August 30 2024).

50 "OPT/Israel: Report Exposes the Role of AI in Israel's Targeting of Civilians & Civilian Infrastructure", Business & Human Rights Resource Centre, December 1 2023, https://www.business-humanrights.org/en/latest-news/optisrael-report-exposes-the-role-of-ai-in-israels-targeting-of-civilians-civilian-infrastructure, (Date of Access: August 29 2024).

51 "Israel's AI Generates 100 Daily Bombing Targets in Gaza: Report", Mirage News, December 8 2023, https://www.miragenews.com/israels-ai-generates-100-daily-bombing-targets-1140004/, (Date of Access: August 29 2024).

number of different data types. AI, which can approve various data formats from diverse sources and convert it in a comprehensible, homogenous form that can be processed has the ability of analyzing relevance and reliability of each data point, as well as merging them with existing records and eventually generating a target profile that can be acted upon, is also required to predict the civilian damage according to reports.

Measuring the accomplishment of this technical possibility over Israel is almost impossible. It is observed that Israel never made distinctions among targets in its countless airstrikes. Identification by AI can be advanced and this can be viewed as a success for Israel but it is a problematic method in terms of public conscience and international law. Moreover, Israel's sensitive, precision strikes are very limited. It is observed that majority of its attacks are carried out by dumb munitions. Use of smart munitions is very limited.[52] Therefore, it is not very possible to obtain open-source information on successes and gains of targeting systems which are AI-supported and truly attach importance on civilian casualties in the case of Israel.

Lavender

It is reported that Israel deployed Lavender AI system, a more advanced and different version of Habsora in intense attacks it carried out after October 7. Later, IDF, on its official website, announced that as a result of efforts of targeting directorate where regular and reserve troops with skills of decryption, cybersecurity and research are posted on several technology roles, they deployed a system that enables employment of automatic tools and works by development of correct and quality intelligence material based on needs for fast detection of targets. Describing this as "Annunciation" in the war, the IDF said that with the assistance of AI and fast and automatic accumulation of updated information, the system generates suggestions for intelligence officer-researcher to ensure full alignment between the machine's suggestions and human identification. IDF also said the damage to irrelevant parties was minimum.[53]

52 Braw, "Israel's Targeting AI: How Capable is It?".

53 "War Diary: Targets Attacked by IDF Forces – Intelligence Division, Air Force, Navy", IDF, (November 2023), https://www.idf.il/אתרי-יחידות/יומן-המלחמה/כל-הכתבות/הפצות/מלחמה-מטרות-שהותקפו-כוחות-צה-ל-אגף-המודיעין-חיל-האוויר-חיל-הים, (Date of Access: August 30 2024).

Media reports said that Israeli army used a previously undeclared AI-supported database in its bombardment of Gaza.[54] It is believed that the system implied here as old system is Habsora. The Lavender system, used for the first time, helped identify 37,000 potential targets linked to Hamas between October 7, 2023 and end of March 2024. It is believed that this number is far higher today.[55] IDF announced they identified 12,000 targets for 27 days while statements of IDF spokesperson after about five months rejected the existence of such a "kill list."[56]

Details of the system emerged in a report published by Israeli-Palestinian publication +972 Magazine and Local Call, a Hebrew-language publication. The report, based on accounts of six Israeli intelligence officers who directly contributed to use of AI during the ongoing war in Gaza and for determining targets for assassination, says the Lavender system played a central role in heavy bombardment of Palestinians especially in the early stages of the conflict.[57]

Although it is expected that humans should verify targets determined by AI, claims emerged that targets determined by the Lavender system were directly approved. The personnel which used the system said people had almost full faith in Lavender and the system registered 37,000 Palestinians as suspected militants for possible airstrikes and marked their homes. The personnel also said targets determined by Lavender were approved within 20 seconds.[58]

According to some sources, Israeli army attacked targets usually not during military operations but while they were at home and at times where they were with their families at night. This strategy stems from the fact it is easier to detect people in their homes for the intelligence. As a result, many Hamas members and officials were targeted along with their families. As a matter of

54 Bethan McKernan, "Israel Uses AI to Identify Bombing Targets in Gaza, Prompting Concern over Civilian Casualties", *The Guardian*, April 3 2024.

55 "Israel's AI Generates 100 Daily Bombing Targets in Gaza: Report".

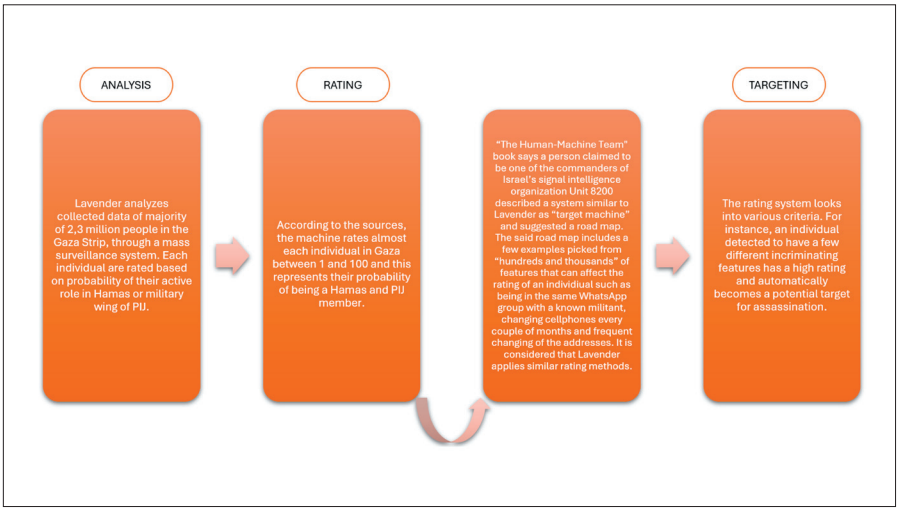
56 "UN Chief 'Deeply Troubled' by Reports Israel Using AI to Identify Gaza Targets", *The Times of Israel*, April 6 2024.

57 Yuval Abraham, "Lavender: The Israeli Army's New AI System That Chooses Bombing Targets in Gaza", +972 Magazine, April 3 2024, https://www.972mag.com/lavender-ai-israeli-army-gaza, (Date of Access: August 30 2024).

58 McKernan, "Israel Uses AI to Identify Bombing Targets in Gaza, Prompting Concern over Civilian Casualties".

fact, the location where the target is unimportant for Israel. This reached to another level when Israel carried out an attack on a United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) school in Nuseirat refugee camp on July 7, 2024.[59] The attack killed 23 people and injured more than 80 others.[60] IDF announced that 8 Hamas members were eliminated in this attack.[61] It is reported that low-ranking officers employing Lavender system marked the target without approval of their superiors and Air Forces proceeded to strike the targets.[62]

Figure 6. Lavender's Target Determination Process


ANALYSIS
Lavender analyzes collected data of majority of 2,3 million people in the Gaza Strip, through a mass surveillance system. Each individual are rated based on probability of their active role in Hamas or military wing of PIJ.
RATING
According to the sources, the machine rates almost each individual in Gaza between 1 and 100 and this represents their probability of being a Hamas and PIJ member.
"The Human-Machine Team" book says a person claimed to be one of the commanders of Israel's signal intelligence organization Unit 8200 described a system similar to Lavender as "target machine" and suggested a road map. The said road map includes a few examples picked from "hundreds and thousands" of features that can affect the rating of an individual such as being in the same WhatsApp group with a known militant, changing cellphones every couple of months and frequent changing of the addresses. It is considered that Lavender applies similar rating methods.
TARGETING
The rating system looks into various criteria. For instance, an individual detected to have a few different incriminating features has a high rating and automatically becomes a potential target for assassination.

Source: +972 Magazine; Brigadier General Y.S., *The Human-Machine Team: How to Create Synergy Between Human & Artificial Intelligence That will Revolutionize Our World*, (Independently, Traverse City: 2021). Compiled from sources by authors.

Lavender's Operation Process

Step 1: Generating Targets

Though it was documented that Israel did not make distinction for civilians in its previous attacks, Israeli sources claimed that IDF acted in line with rules of In-

59 Paul Adams, "Israel's AI-Driven War: How the Military Uses Technology to Select Targets", BBC News, July 7 2024.

60 "Israel strikes school again in Nuseirat: 23 dead", NTV, July 16 2024.

61 "Israel-Hamas War: Live Updates", *The Jerusalem Post*, June 7 2024.

62 Abraham, "Lavender".

ternational Law Department for human targets in its attacks prior to October 7. However, sources who used Lavender stated that the army adapted a dramatically different approach after October 7. Israeli army, as part of its Operation Swords of Iron, decided to mark all members of Hamas' military wing as human targets, regardless of their rank or military significance. It was announced that this was confined to high-level targets in previously used systems.[63] Low-ranking Hamas members viewed as militants by Israel were also marked by Lavender and targeted. Lavender operators named them as "garbage targets".[64]

Under the old system, cross-checking the verification of evidence on someone as high-ranking member of Hamas' military wing, their residence and communication information, real-time surveillance to see if he went home was very easy as the target lists were only a few dozen and one personnel would be able to do it on his/her own. But when the target list was expanded to include thousands of lower-ranking members, it became clear that existing human resource cannot tackle it and a computer-supported system is needed. Thus, human operators are replaced with use of AI.

According to the sources, the decision on automatic approval of the Lavender system's "kill lists" made about two weeks after the start of the war.[65] This decision is made after manual confirmation of a random sample of a few hundred target picked by AI by intelligence personnel. When the assessment showed Lavender had 90 percent accuracy in determining individuals linked to Hamas, Israeli army approved comprehensive use of the system. From that moment, identification of a person by Lavender as a Hamas member is viewed as an order and the requirement of controlling how the system came to this conclusion or raw data the determination is based on, ended.

Step 2: Linking Targets to Family Homes

The next stage in the assassination procedure is identifying where to attack the targets that Lavender generates. Sources contradicting Israeli army's official statements say one of main causes of unprecedented level of casualties in bombardments were army's attacks on targets in their family homes while the families were present, in a systematic way. It is explained away as that use of automatic systems for intelligence makes it easier to mark the family

63 Abraham, "Lavender".

64 Abraham, "Lavender".

65 Abraham, "Lavender".

homes. This is because everyone in Gaza had a private house which they could be associated and army's surveillance systems can easily and automatically link individuals to family homes. This is due to the fact that Israel's system in Gaza was based on mass surveillance.

In order to identify the moment which operatives enter their houses in real time, various additional automatic identification software have been developed. These programs track thousands of individuals simultaneously, identify when they are at home, and send an automatic alert to the targeting officer, who then marks the house for bombing. One of several of these tracking programs, is called "Where's Daddy?" When the pace of attacks dropped, more targets were added to the system. The fact that those additions are made by low-ranking officers points out that a hierarchy of approval does not exist. One of the most important confessions regarding the attacks is that children and women make up majority of casualties:

> "Let's say you calculate that there is one Hamas operative plus 10 civilians in the house. Usually, these 10 will be women and children. So absurdly, it turns out that most of the people you killed were women and children."[66]

Step 3: Choosing a Weapon

Small-scale and smart munitions with localized impact are supposed to be used in attacks to minimize civilian losses but it was evident that targets marked by Lavender were attacked by dumb bomb/munitions only. Thus, munitions are chosen without consideration of civilian losses.[67]

Step 4: Civilian Casualties and Collateral Damage Analysis

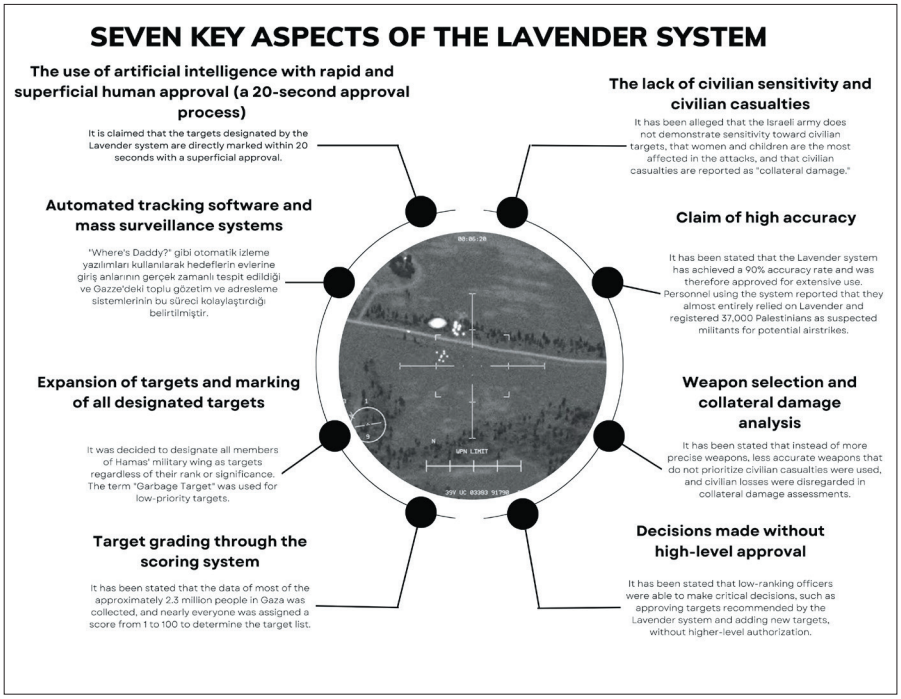
Calculation of collateral damage is also made by Lavender. However, approval of Israeli army's International Law Department on collateral damage truly contradicted the international legal system. A source said number of collateral damage degree for every target, including those marked earlier, was fixed at 20 civilians. It is clear that "collateral damage degree" for a marked target is applied without regard to targets' rank, military importance and age. Thus, when a Hamas member of any rank is identified, civilian casualties were viewed as collateral damage was disregarded and there was no specific case-by-case examination to weigh the military advantage of assassinating them against the expected harm to civilians. In some cases, col-

66 Abraham, "Lavender".

67 Braw, "Israel's Targeting AI: How Capable is It?".

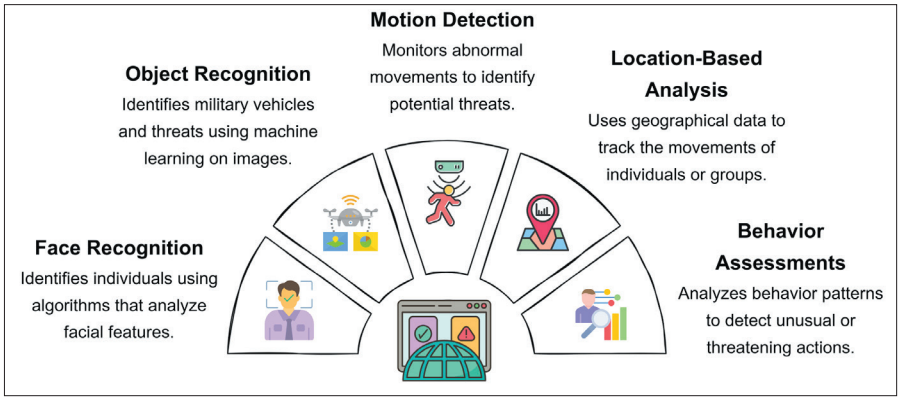
lateral damage degree was at 100. Therefore, it is clear that Israel used AI to indiscriminately strike targets and reported civilian casualties as "collateral damage." Working system of Lavender is basically as shown in Figure 7.

Figure 7. Significant Critical Elements of the Lavender System


SEVEN KEY ASPECTS OF THE LAVENDER SYSTEM
The use of artificial intelligence with rapid and superficial human approval (a 20-second approval process)
It is claimed that the targets designated by the Lavender system are directly marked within 20 seconds with a superficial approval.
The lack of civilian sensitivity and civilian casualties
It has been alleged that the Israeli army does not demonstrate sensitivity toward civilian targets, that women and children are the most affected in the attacks, and that civilian casualties are reported as "collateral damage."
Automated tracking software and mass surveillance systems
"Where's Daddy?" gibi otomatik izleme yazılımları kullanılarak hedeflerin evlerine giriş anlarının gerçek zamanlı tespit edildiği ve Gazze'deki toplu gözetim ve adresleme sistemlerinin bu süreci kolaylaştırdığı belirtilmiştir.
Claim of high accuracy
It has been stated that the Lavender system has achieved a 90% accuracy rate and was therefore approved for extensive use. Personnel using the system reported that they almost entirely relied on Lavender and registered 37,000 Palestinians as suspected militants for potential airstrikes.
Expansion of targets and marking of all designated targets
It was decided to designate all members of Hamas' military wing as targets regardless of their rank or significance. The term "Garbage Target" was used for low-priority targets.
Weapon selection and collateral damage analysis
It has been stated that instead of more precise weapons, less accurate weapons that do not prioritize civilian casualties were used, and civilian losses were disregarded in collateral damage assessments.
Target grading through the scoring system
It has been stated that the data of most of the approximately 2.3 million people in Gaza was collected, and nearly everyone was assigned a score from 1 to 100 to determine the target list.
Decisions made without high-level approval
It has been stated that low-ranking officers were able to make critical decisions, such as approving targets recommended by the Lavender system and adding new targets, without higher-level authorization.

Source: Compiled by authors.

Figure 8. Basic Data Used for Target Detection in Recognition Systems


Motion Detection
Monitors abnormal movements to identify potential threats.
Object Recognition
Identifies military vehicles and threats using machine learning on images.
Location-Based Analysis
Uses geographical data to track the movements of individuals or groups.
Face Recognition
Identifies individuals using algorithms that analyze facial features.
Behavior Assessments
Analyzes behavior patterns to detect unusual or threatening actions.

Source: Compiled by authors.

AI-based target detection systems became widespread after AlexNet model which offers high accuracy rates and hailed as revolutionary emerged in 2012.[68] Yet, images derived from satellite and UAVs are not sufficient to detect a target alone. The target detection requires object recognition, detection of movement, location-based analyses, assessment of human behavior and combined use of a multi-layered analysis of various data.[69] Diversity and complexity of data sources are factors directly affecting the system's performance and accuracy.

In target surveillance, "every object should have a unique tracking identity to distinguish them across a sequence of frames in time and should be positioned in coordinates that must be determined for each detected object."[70] Hence, a target detection system, even if works on high accuracy, has several limitations. Different and complex data sources directly affects the system's performance and accuracy and this in turn may lead to faulty targeting and civilian casualties.

The integration of object recognition, motion detection,, location-based analysis and human behavior assessment requires complex data fusion techniques. Challenges such as occlusion, congestion, varying object sizes, distortions in video footage, dynamic lighting conditions and background complexity pose significant obstacles to target detection.[71]

Battlefield in Gaza makes this detection more difficult; it is an environment where an entirely damaged and constantly bombed city is located, with ruins and rubble everywhere. This heightens the level of said challenges. Similar features of the rubble drive certain data out of use and brings use of GPS data to spotlight. However, a drop in other data in surveillance of a

68 Alex Krizhevsky, Ilya Sutskever and Geoffrey E. Hinton, "Imagenet Classification with Deep Convolutional Neural Networks", *Advances in Neural Information Processing Systems*, (January 2012), p. 25.

69 Sara Minaeian, Jian Liu and Young Jun Son, "Effective and Efficient Detection of Moving Targets from a UAV's Camera", *IEEE Transactions on Intelligent Transportation Systems*, Volume: 19, Issue: 2, (2018), p. 497-506; C. P. Chen, Hong Li, Yantao Wei, Tian Xia and Yuan Yan Tang, "A Local Contrast Method for Small Infrared Target Detection", *IEEE Transactions on Geoscience and Remote Sensing*, Volume: 52, Issue: 1, (2013), p. 574-581; Bo Du and Liangpei Zhang, "Target Detection Based on a Dynamic Subspace", *Pattern Recognition*, Volume: 47, Issue: 1, (2014), p. 344-358.

70 Ioannis Daramouskas, Dimitrios Meimetis, Niki Patrinopoulou, Vaios Lappas, Vassilis Kostopoulos and Vaggelis Kapoulas, "Camera-Based Local and Global Target Detection, Tracking, and Localization Techniques for UAVs", *Machines*, Volume: 11, Issue: 2, (2023), p. 315.

71 Aleksandr Kondakov, Ruslan Yanchyshyn and Viktor Vdovychenko, "Object Detection and Object Tracking Explained with Real Examples", Lemberg Solutions, June 26 2023, https://lembergsolutions.com/blog/object-detection-and-object-tracking-explained-real-examples, (Date of Access: October 30 2024).

moving Hamas member without a fixed residence and prominence of GPS increases room for error. Moreover, Hamas members covering their faces challenge the target detection and surveillance. Another challenge is movement through tunnels in certain areas. Technically, accuracy rate of a system with these challenges is disputed.

Target detection system is supposed to be force with benefits like faster detection of targets, saving time and munitions and minimizing civilian casualties but it is difficult to achieve its practical purpose under heavy bombardment and amid indiscriminating attacks disregarding civilians. The system's efficiency is highly disputed in attacks where Israel's true goal is destroying targets without considering civilian casualties under heavy bombardment and gunfire. When coupled with potential issues with accuracy rate, it can be concluded that achieving the results of analysis and predictions of systems like Lavender is difficult.

AI-SUPPORTED GUNSIGHT AND INFANTRY RIFLE

Smart Shooter

Rifles developed for and used by Israeli army, land forces are equipped with various AI-supported gunsights. Smart Shooter, an Israel-based developer of fire control systems obtained system design approval in 2020 from Irregular Warfare Technical Support Directorate (IWTSD) for its project.[72]

Smart Shooter's SMASH series, present users with automatic ballistic calculations to track and strike targets beyond a distance of 600 meters, thanks to its varying zooming features derived from fire control optics technologies. SMASH is equipped with image processing algorithms and can sense different types of targets such as human beings, vehicles or UAVs. The system can track multiple targets and lock on the target prioritized by the operator. The system built on open architecture can create an interface with radar and external sensors and can be integrated into different applications.

72 Meredith Roaten, "Israeli Firm Delivers Advanced Targeting System", National Defense, October 6 2021, https://www.nationaldefensemagazine.org/articles/2021/6/9/israeli-firm-delivers-advanced-targeting-system, (Date of Access: August 30 2024).

Smart Shooter, one of the AI-supported systems actively used by Israel's Land Forces and Special Forces is also reported to be purchased by ten NATO countries.[73]

ARCAS

ARCAS (Assault Rifle Combat Application System) developed by Elbit Systems, an Israel-based defense electronics company, is based on data analytics and AI.[74] ARCAS is an AI-supported system designed specifically for infantry units and can be integrated into assault rifles. This system taps advanced technology to raise situational awareness of soldiers in the battlefield and their operational efficiency.

Those experienced it and soldiers say ARCAS's AI-supported gunsight offers a video-game like experience. ARCAS contains an imaging system which can be mounted on a helmet or rifle to facilitate aiming and shooting for soldiers. This system provides augmented reality (AR) layers to boost soldier's aiming accuracy and accelerate targeting process. The system also automatically detects threats in the field and provides visual and audio warnings to soldiers. AI algorithms analyze environmental data to detect the type and location of the target.

The Elbit officials say that the system is easy to adapt and adjust and it was developed not only for Special Forces but also average infantry troops. Arie Chernobrov, general manager of Elbit Security Systems said about the system:

> "We made it very intuitive so it looks like PlayStation's Fortnite [video game]; it shows range, wind and ammo left, etc."[75]

ARCAS significantly increases soldier's situational awareness. The system provides a screen where soldiers can visually perceive the location of hostile and friendly units in the field. This helps making swift decisions in the battlefield.

73 Seth J. Frantzman, "New AI System Fills Rifle Sights with Extensive, Easy-to-Digest Info", C4ISRNET, September 7 2021, https://www.c4isrnet.com/artificial-intelligence/2021/09/07/new-ai-system-fills-rifle-sights-with-extensive-easy-to-digest-info/, (Date of Access: August 30 2024).

74 Dean Shmuel Elmas, "10 NATO Armies Buy Kibbutz Yagur's Smartshooter AI Sights", Globes, June 23 2024, https://en.globes.co.il/en/article-10-nato-armies-buy-kibbutz-yagurs-smartshooter-ai-sights-1001482189, (Date of Access: August 30 2024).

75 Frantzman, "New AI System Fills Rifle Sights with Extensive, Easy-To-Digest Info".

UAVs

Israel is regarded as one of the leading countries in the world in development of AI-supported UAVs. Innovation capacity in defense industry and strategic investments it made in technology in particular help it to advance in this field. Thanks to these investments, Israel acquired a noteworthy expertise in development of AI-based UAVs.

AI-supported UAVs in the field of defense increase Israel's operational capabilities and offer fast, efficient and low-cost solutions against asymmetrical threats. These platforms play critical role especially in border security, reconnaissance, surveillance and target detection missions. Thanks to AI algorithms, these platforms have the ability of real-time data processing and autonomous decision-making. This helps accomplishing complicated tasks without human intervention.

Harop

Harop is a loitering munitions system developed by IAI. It has begun development in 2000s with experience accumulated from long-established Harpy project.[76]

Harop has AI-supported target detection and surveillance systems. The UAV analyzes radar waves, automatically detects threats and heads towards them. AI support is usually a complimentary element in Harop which utilizes human-in-the-loop mode remotely controlled by an operator. The Harop operator can select static or moving targets detected by UAV's electrooptic (EO) sensor.

Israeli army actively used Harop UAVs especially in operations against Hamas after October 7. IDF announced shooting a Hamas target in the Erez crossing on the border with Gaza.[77] It is clear Israel used Harop loitering munition in the attack. Harop loitering munition used in this attack showcases operational efficiency of AI-supported algorithms in detecting and eliminating the target.

76 Muhammed Ayyıldız, "Israel's Loitering Munitions: Harpy and Harop", Savunma Sanayi ST, October 7, 2020, https://www.savunmasanayist.com/israil-kamikaze-iha-harpy-harop/, (Date of Access: August 30 2024).

77 "IDF Says It Carried Out Drone Strike on Hamas Cell Near Gaza Border Crossing", *The Times of Israel*, August 21, 2024.

Heron TP

Heron TP (Eitan) is a strategic UAV platform developed by IAI. This platform stands out with its AI-supported analytical systems as well as *high altitude long endurance* (HALE) capabilities.

With its advanced sensor systems, Heron TP can perform intelligence gathering, target detection and surveillance in complicated fields of operations with several variables, with a high accuracy. Thus, it speeds up making tactical decisions by providing Israeli army real-time data in operational planning. Collected image and signal data was processed by AI-based algorithms for detection, surveillance and analysis of the targets.

After October 7, 2023, Israel actively used Heron TP UAVs in operations against Hamas. These UAVs are particularly used in intelligence gathering, target detection and surveillance missions during clashes in Gaza. Before the land offensive, it carried out a busy schedule of flights over the region to provide intelligence.[78] AI-supported flight control system of Heron TP adapts to battlefield dynamics in real-time, providing secure and efficient operations in low-visibility, high-risk or sensitive data-required areas. This capability has provided an important support to the Israeli army prior to the land operations.

Rotem

Rotem (IAI Rotem L) is one of portable UAV platforms with high capability of maneuvering developed by IAI. Vertical Take-off and Landing (VTOL) feature provides operational flexibility especially in narrow spaces and in complicated urban war zones, making Rotem an ideal vehicle for urban operations. The system has autonomous functions but can be manually controlled as well. It is an efficient vehicle both in defense and offense.[79]

Rotem's AI-supported image processing algorithms relieves operators of their burden by operating on high accuracy in target detection and surveillance. UAV, through its autonomous functions, can run environmental

78 Anna Ahronheim, "IDF Strikes Hamas Terrorists Attempting to Fire Rockets from Gaza", *The Jerusalem Post*, October 7 2023.

79 "Rotem: Multi-Rotor Tactical Loitering Munition", IAI, August 30 2024, https://www.iai.co.il/p/rotem, (Date of Access: August 30 2024).

analysis and threat assessment real-time and can make quick decisions in critical situations. Due to its nature as a loitering munition system with Vertical Take-Off and Landing that enables more flexible use in urban and narrow spaces, it was used in ground offensive launched after October 7. In addition, it worked in coordination with IDF's land units and supported armored and infantry units.[80] Through Rotem's AI system, IDF's coordination between armored and infantry units during the ground offensive reached to a higher level. Its usage in narrow conflict zone raises awareness of soldiers in the field and allows safe advances.

Skylark

Skylark UAV is a light UAV platform developed by Israel-based defense technologies company Elbit Systems used in tactical reconnaissance and surveillance missions. The Skylark family is known better as portable UAVs used by infantry units and Special Forces. Those UAVs are used in low-intensity conflict zones, border security and short-range reconnaissance missions. Skylark has several versions and editions. AI-supported features of the Skylark series minimize operator intervention by enhancing UAV's autonomous functions and increase mission efficiency. Thus, it enables high accuracy in missions like target detection and surveillance and significantly increases awareness of operators in battle conditions.[81]

It was one of UAVs actively used after October 7. A unit called "Sky Rider" within IDF is in charge of flights of such UAVs. In October 2023, IDF released this statement about the unit:

> "Sky Rider teams join infantry forces, including special forces and reconnaissance battalions, and assist them in maneuvering safely by acting as their 'eyes in the sky.' The teams are trained to fly UAVs that give the forces an aerial overview of their surroundings."[82]

80 Ahronheim, "Israel Strikes Syrian Military Targets in Response to Rocket Fire".

81 "Unmanned Aerial Systems (UAS)", Elbit Systems, August 30 2024, https://elbitsystems.com/products/uas, (Date of Access: August 30 2024).

82 David Adesnik, "Israel-Hamas War: The Israeli Drones Keeping the IDF Safe in Gaza", Foundation for Defense of Democracies, December 22 2023, https://www.fdd.org/analysis/2023/12/22/israel-hamas-war-the-israeli-drones-keeping-the-idf-safe-in-gaza, (Date of Access: August 30 2024).

Hermes 900

Hermes 900 is a medium-altitude long-endurance (MALE) UAV developed by Elbit Systems and offers high performance for modern security and military operations. Hermes 900 is used in missions like reconnaissance, surveillance, intelligence, target detection and tracking and can perform a fully autonomous flight, mission planning and data analysis thanks to its AI-supported systems. Fitted with EO and infrared (IR) cameras, the vehicle provides high-resolution images in daytime and nighttime operations. In addition, its synthetic-aperture radar helps acquisition of clear radar images in bad weather. AI-based algorithms provide high accuracy in Hermes 900' target detection and tracking and relays fast and reliable data to operators through real-time data analysis. This feature helps soldiers on the ground to make more accurate and fast decisions and increases operational efficiency.[83] Israel actively uses Hermes 900 after October 7.[84]

FireFly

FireFly is part of Rafael's SPIKE family of precision-guided munitions family and shares guidance system and other components of SPIKE NLOS missile. This UAV with Vertical Take-Off and Landing (VTOL) feature can function both as operator-controlled or in autonomous mode and can attack targets Beyond-The-Line-of-Sight (BLOS). With double IR and EO trackers and proximity sensors, it can track "agile targets" and can attack targets behind cover by going through narrow spaces such as doors and windows. In addition, it optimizes its flight course by running an environmental analysis thanks to its AI-supported algorithms and performs autonomous duties with high accuracy.[85]

Weighing 3 kilograms, FireFly carries a 350 grams explosive warhead in attack mode. In reconnaissance mode, an extra battery can be installed to improve its endurance. This UAV which has a 1,000 meters range can

83"Elbit Hermes 900", Military Factory, August 30 2024, https://www.militaryfactory.com/aircraft/detail.php?aircraft_id=1236, (Date of Access: August 30 2024).

84 "Israel is challenged by struck Hermes 900s", Savunma TR, July 8 2023, https://www.savunmatr.com/israil-dusurulen-hermes-900ler-nedeniyle-zorluk, (Date of Access: August 30 2024).

85 "Israel's Firefly Urban Warfare Drone Spotted in Jenin", TWZ, July 5 2023, https://www.twz.com/israels-firefly-urban-warfare-drone-spotted-in-jenin, (Date of Access: August 30 2024).

reach a maximum dive speed of 70 kilometers per hour in the attack mode. With autonomous flight system and AI support, FireFly can independently detect targets, monitor them and carry out the attack when needed without intervention of the operator. Besides, it conducts real-time data processing and analyzes and reports to operator in the field, enabling critical decisions to be made swiftly.

FireFly was ordered by Israeli Ministry of Defense first in 2020 and used in operations in Jenin. After October 7, 2023, it was spotted flying above a neighborhood in occupied West Bank.[86]

Israel's potential to use AI technology in UAVs it owned cannot be overlooked. In a technical sense, UAVs perform identified missions through software-based technologies. Functions like development of autonomous abilities, target detection and elimination are controlled through software depending on the hardware. So, adding AI skills to these systems is possible while updating them as well as during their production. Full autonomy for systems and autonomous strikes by AI on targets marked by the Lavender system is also technically possible. Yet, Israel limited sharing official and detailed information about this system, making access to genuine data about them a challenge. However, given Israel's approach on high-level AI technologies and their strategic use, this is a high possibility. In this context, it can be concluded that Israel's AI skills are at a very advanced level in terms of UAVs as well.

Counter UAV systems

Israel also runs comprehensive research for development of AI-supported counter UAV systems. In this context, Goshawk, developed by ROBOTICAN and introduced at GoforIsrael Conference, employs innovative methods to prevent hostile UAVs and is also known as "angry bird". This system named after "predatory bird" in Hebrew is designed for security in urban areas with low risk.

Goshawk utilizes a net effector to neutralize hostile UAVs instead of destroying them and thus, prevents shrapnel risk particularly in civilian residential areas. The system, which can detect hostile UAVs at certain ranges

86 "Israel's Firefly Urban Warfare Drone Spotted in Jenin".

through radar systems or radar network integration, employs machine vision and AI technologies to analyze threats.

The system developed by ROBOTICAN works on algorithms based on behavior of tracking and intervention of predatory birds and quickly calculates the orbit of the target, as well as charting the route of intervention. The entire process runs autonomously with the support of AI.[87]

It is observed that Hamas, despite possessing low technology, increasingly uses small UAVs which can go undetected by radar systems for attacks. Goshawk is developed against these threats and according to ROBOTICAN's official website, it is an innovative system used by Israel that intercepted 261 UAVs so far.[88]

Heuristic and metaheuristic algorithms that emerged as a field of AI, is used for creative solutions to certain problems by taking inspiration from the nature.[89] These algorithms modeled after animal behaviors are prominent in swarm intelligence and nature-inspired methods. Systems like Goshawk works with metaheuristic algorithms mimicking hunting strategies of predatory birds, detects threats with high accuracy and determines ideal course for swift intervention. Metaheuristic algorithms used in defense and warfare are becoming increasingly prevalent in military strategy and tactics.[90] In the beginning, these algorithms were used in resolving simple optimization problems. Yet, with advances in defense technologies, they became algorithms that can make more complicated, real-time analysis and be used in autonomous decision-making processes. In this context, Goshawk is one of the pioneering systems.

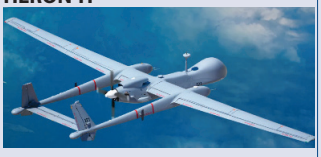
87 "Israeli 'Angry Bird' will Hunt Enemy Drones", *Israel Today*, May 23 2023.

88 "Goshawk Autonomous Drone Interceptor", ROBOTICAN, November 1 2024, https://robotican.net/goshawk-autonomous-drone-interceptor, (Date of Access: August 30 2024).

89 Sachin Desale, Akhtar Rasool, Sushil Andhale and Priti Rane, "Heuristic and Meta-Heuristic Algorithms and Their Relevance to the Real World: A Survey", *International Journal of Computer Engineering in Research Trends*, Volume: 351, Issue: 5, (2015), p. 2349-7084.

90 P. M. Pradhan and D. K. Pratihar, "Comparative Performance of Nature-Inspired Optimization Algorithms in Defence Applications", *Defence Science Journal*, Volume: 69, Issue: 3, (2019), p. 300-306.

Table 1. Basic Features of Israel's UAVs with AI

	Basic Flight Performance Criteria	AI and Advanced Features
HAROP	• Length: 2,5 meters • Wing span: 3 meters • Maximum speed: 185 km/h • Maximum flight range: 1.000 kms • Endurance: About 6 hours •Warhead weight: 23 kgs	• AI support • Autonomous target recognition • Visual and thermal sensors • Autonomous obstacle aversion • Situational awareness • Operator feedback and control • Low-noise operation
HERON TP 	• Length: 14 meters • Wing span: 26 meters • Maximum speed: 407 km/h • Flight range: 7.400 kms • Maximum flight altitude: 14.000 ms, 46.000 ft • Endurance: +30 saat • Maximum takeoff weight: 5.400 kgs • Useful load capacity: 2.700 kgs	• AI-supported target detection and surveillance systems • BLOS/SATCOM • Triple redundant avionics • Automatic taxi-takeoff and Landing (ATOL) • Sensor fusion • Big data analysis • Advance electro-optic / infrared (EO/IR) cameras, SAR, ground surveillance radars, SIGINT/ELINT and moving target detection radars
ROTEM	• Maximum takeoff weight: 4,5 kgs • Endurance: 30- 45 minutes • Active range: 10 kms • Operational altitude: Suitable for low altitude operations • Useful load capacity: Up 1 kg	• Internal sensor fusion • Fully automatic operation and routing • Foldable and can be carried by one soldier • Quiet up to a few hundred meters • Less visibility in urban areas • Sensitive assault feature
SKYLARK 3 Hybrid	• Skylark UAV family has more than 6 variations. Their average technical specifications vary. • Wing span: 4,7 ms (15 ft) • Maximum takeoff weight: 48 kgs (106 lbs) • Maximum endurance: 18 hours • Maximum altitude: 3.700 ms (12.000 ft) • Maximum range: 120 kms (75 miles)	• Autonomous and semi-autonomous flight modes • Advanced target surveillance and reconnaissance • Backup feature and error tolerance • Low noise and invisibility capacity • Over the hill intelligence • Force and convoy protection • Strategic infrastructure protection • Border patrol • Security operations

HERMES 900 	• Length: 8,3 ms • Wing span: 15 ms • Maximum speed: 222 kms/h • Gross weight: 1.100 kgs • Endurance: +36 hours • Maximum takeoff weight: 7.560 kgs • Useful load capacity: 350 kgs • Maximum altitude: 30.000 ft (9.100 ms)	• Various high-performing sensors in a wide spectrum • EO/IR/laser marking long-range EO/IR • SAR/GMTI and MPR + AIS • ELINT, EW, COMINT, COMJAM • Wide area surveillance / mapping • Hyperspectral • Communications relay • AI-supported analysis
FireFly 	• Length: 80 mms • Depth: 80 mms • Height: 400 mms • Maneuvering speed: 60 km/h • Dive speed: 70 km/h • Range: 500 ms in dense urban areas, 1,500 ms in open areas • Endurance: Armed mission 15 minutes; reconnaissance mission, 30 minutes	• Minimum noise coaxial rotor • BLOS • Double IR and EO seeker • VTOL (vertical take-off and landing) • AI-supported dynamic tracking • Light and portable

Source: "HAROP", IAI, https://www.iai.co.il/p/harop, (Date of Access: August 30 2024); "Heron TP-MALE Drone", IAI, https://www.iai.co.il/p/heron-tp, (Date of Access: August 30 2024); "ROTEM", IAI, https://www.iai.co.il/p/rotem, (Date of Access: August 30 2024); "SKYLARK-3", Elbit Systems, https://elbitsystems.com/product/skylark-3, (Date of Access: August 30 2024); "HERMES-900", Elbit Systems, https://elbitsystems.com/product/hermes-900, (Date of Access: August 30 2024); "SPIKE FIREFLY", Rafael, https://www.rafael.co.il/system/spike-firefly, (Date of Access: August 30 2024). Compiled by authors using aforementioned sources.

GROUND VEHICLES

Merkava Mk. 4 Barak

Merkava Mk. 4 Barak tank is an innovative ground combat vehicle equipped with the highest technologies. This tank stands out with its advanced technological features integrated with AI and high firepower. In IDF's official technology bulletin, Merkava Mk. 4 Barak is promoted as a tank developed "in order to improve the Armored Corps' operational capabilities on the modern battlefield" and it gives a new perspective to modern warfare strategies with its AI-supported systems, updated sensors and virtual reality (VR) capabilities.[91]

91 "Meet the Merkava Mk. 4 Barak", IDF, September 15 2024, https://m.www.idf.il/en/mini-sites/technology-and-innovation/meet-the-merkava-mk-4-barak, (Date of Access: August 30 2024).

"Iron Vision" system in the tank raises situational awareness by providing a 360-degree sight to tank commanders. This system operating in a way similar to warplane helmets increases efficiency especially in urban warfare. The commander can see exterior and interior of the vehicle real time and thus, can detect threats swiftly, enhancing decision-making processes. Such systems play a critical role in terms of operational efficiency and security in modern warfare technologies.[92]

The AI-supported target detection system process data from tank's sensors with AI algorithms and automatically identifies, classifies and prioritize targets. Thus, the crew can intervene to targets in a faster and more efficient way. The system heightens tank's environmental awareness and accelerates decision-making processes, providing strategic advantage in the battlefield. These processes can also be run autonomously.[93]

AI is a full-scale revolution in target detection and identification process but this does not apply to response process. The tank provides the crew the advantage of simpler tasks by plain and clear relay of information. An Elbit Systems representative says this is about cognitive load, about how much information one can process and where algorithms managing images provided to the crew become active at that point. This may shorten response time but it won't have a dramatic impact as it has in target detection process.

Merkava Mk. 4 Barak which has an active protection system called Trophy APS that enables protection from anti-tank guided missiles (ATGM) and RPGs was actively used in ground offensive by IDF after October 7.[94]

Jaguar UGV

Jaguar unmanned ground vehicle (UGV) is a vehicle equipped with advanced AI and autonomous systems which boasts high technology used in border security and reconnaissance missions. This system developed by IAI's

92 "Meet the Merkava Mk. 4 Barak".

93 Paolo Valpolini, "Israel Starts Delivering the 5th Gen Merkava Barak Tank to Its Armoured Units", EDR Magazine, September 22 2023, https://www.edrmagazine.eu/israel-starts-delivering-the-5th-gen-merkava-barak-tank-to-its-armoured-units, (Date of Access: September 20 2024).

94 "Israel Deploys World-Renowned Merkava IV Tank in Land Operations Against Hamas in Gaza Strip", Army Recognition, October 24 2023, https://www.armyrecognition.com/news/army-news/2023/israel-deploys-world-renowned-merkava-iv-tank-in-land-operations-against-hamas-in-gaza-strip, (Date of Access: September 20 2024).

subsidiary Elta Systems is actively used on Israel's Gaza border. Jaguar has a high capacity of autonomy that allows it move independently by sensing obstacles around it and can chart its own course to reach targets during the missions. This autonomous movement skill enables it to run environmental scans and perceive risks and threats.[95]

Jaguar's highly sensitive sensors help it to work effectively in challenging weather, in the fog or concentration of dust. High-resolution cameras and thermal imaging systems it has allow the vehicle to perform both daytime and night-time tasks. Its AI-supported systems send feedback to command control center after sensing potential threats while critical assault decisions are made through control of human operators. However, target surveillance and aiming are largely performed autonomously by AI.[96]

Another spotlight of Jaguar is autonomous charging system. The vehicle can automatically track its energy level in lengthy patrol missions and can direct itself to the charging station when in need. These innovative features boost efficiency of the vehicle in modern military operations and aims to minimize human intervention in the field of border security. This system successfully used both in defense and reconnaissance missions is viewed as one of the most advanced applications of AI and autonomy technologies in the military field. Since 2021, Jaguar performs border patrols.[97]

IRIS UGV

Integrated RAS Intelligence System (IRIS) is a light and modular UGV developed by Israel-based Roboteam company and is optimized for reconnaissance, intelligence and surveillance missions in dangerous and remote areas.

95 Apoorva Jain, "Watch: Israel Military Deploys High-Tech Jaguar Robot to Patrol Gaza Border", The Eur-Asian Times, June 29 2021, https://www.eurasiantimes.com/watch-israel-military-deploys-high-tech-jaguar-robot-to-patrol-gaza-border, (Date of Access: September 15 2024).

96 Sebastien Roblin, "Israel's Newest High-Tech Border Guard: The Jaguar Robot", The National Interest, August 21 2021, https://nationalinterest.org/blog/reboot/israel%E2%80%99s-newest-high-tech-border-guard-jaguar-robot-192061, (Date of Access: September 15 2024).

97 "Israel's Jaguar Unmanned Ground Vehicle is Patrolling Gaza Border", War Happens, August 21 2021, https://warhappens.org/israels-jaguar-unmanned-ground-vehicle-is-patrolling-gaza-border, (Date of Access: September 15 2024).

Highlights of the system include its physical feature and advanced AI and autonomous capacity.[98]

With its compact size, IRIS can be efficiently used in narrow spaces, underground tunnels and areas with access challenges. Its modular design allows the vehicle to be adjusted for different tasks. The vehicle can be integrated with various sensors, cameras and communications systems and this makes it a versatile and flexible solution. High-resolution cameras fitted on it provides features of 90-degree incline and zoom while its IR LED lighting system makes it suitable both for daytime and nighttime operations.

IRIS' AI-supported sensors, combined with autonomous movement ability, allows it to overcome obstacles without intervention of the operator. Thus, the system can autonomously reach the target zone and return after performing the task. In addition, this vehicle which was adapt to different mission scenarios, is fitted with tactical arms and hooks for operations in underground tunnels and narrow spaces.

IRIS has the ability of real-time transfer of video and audio data it collected and this feature is a critical factor directly affecting the success of the operations. ROCU-7 used as control unit can work on Android-based devices or IP-encrypted MESH communication technology.

AI-supported decision-making skills puts IRIS above others as a vehicle that can sense obstacles and can move autonomously. The system can make suggestions to the operator by analyzing data it collected during the mission. Moreover, thanks to its ability to distinguish threats from objects, it helps the operator in decision-making process by offering high accuracy reconnaissance and surveillance.[99]

IRIS is used for purpose of increasing security of military operations and reconnaissance especially in challenging environments such as underground tunnels, buildings and narrow corridors. This advanced system provides a significant advantage in modern battlefield by increasing the security and efficiency of the operations.

98 "Roboteam IRIS", Army Technology, https://www.army-technology.com/projects/roboteam-iris/?cf-view, (Date of Access: September 15 2024).

99 "Roboteam IRIS".

Carmel Combat Vehicle

Carmel is a next-generation, light armored combat vehicle developed by IDF and supported by Israeli Ministry of Defense. This project is conducted by Israel's leading defense industry companies IAI, Elbit Systems and Rafael Advanced Defense Systems. IAI, the main contractor, is leading the production process of Carmel.

Several sources said in 2019 that the project was completed and in commission though the information is uncertain. In addition, there are claims that this vehicle was used in Rafah based on some footage emerged in May 2024.[100]

Despite its light structure, Carmel is equipped with AI, autonomous systems and advanced sensors and is designed to provide superior operational capabilities in modern warfare. It was an innovative platform developed in line with Israel's future war scenarios. It was aimed to reduce the number of crew to two and to achieve this, the vehicle was fitted with sensors increasing the environmental awareness. With its AI-supported systems, it can autonomously perform target detection and attack missions. Its ability to perform with closed-hatch allows the crew to stay in the vehicle to perform operations during challenging combat conditions and this reinforces both security and efficiency.[101]

Another significant feature of is autonomous driving. The vehicle can overcome several obstacles without human intervention and can chart its own course. The vehicle, designed especially for use in urban warfare and asymmetric war environments is regarded as an important step in modern warfare technologies.[102]

100 "Did the Israeli Defense Forces Send Remote-Controlled M113 Zelda APCs to Rafah?", Army Recognition, May 30 2024, https://armyrecognition.com/news/army-news/army-news-2024/did-the-israeli-defense-forces-send-remote-controlled-m113-zelda-apcs-to-rafah, (Date of Access: September 20 2024).

101 "IMOD Outlines Plans for Phase 2 of Carmel Programme", Janes, December 11 2022, https://www.janes.com/osint-insights/defence-news/land/future-armoured-vehicles-survivability-2022-imod-outlines-plans-for-phase-2-of-carmel-programme, (Date of Access: September 20 2024).

102 "Israel Aerospace Industries Selected as Prime Contractor for Carmel Future AFV", Defence Procurement International, October 11 2021, https://www.defenceprocurementinternational.com/features/land/israel-aerospace-industries-selected-as-prime-contractor-for-carmel-future-afv, (Date of Access: September 20 2024).

Table 2. Basic Features of Ground Vehicles Israel Used After October 7

	Basic features	AI and Advanced Features
Merkava Mk. 4 Barak	• Main weapon: 120 mm smoothbore cannon • Crew capacity: 4 (commander, gunner, driver, loader) •Armor: Modular composite armor resists high-explosive anti-tank (HEAT) shells. • Maneuvering: Maximum speed around 60 km/h, strong performance in the field • Power: 1.500 horsepower diesel engine. • Weight: About 65 tons	• Threat perception: AI-supported threat perception system identifies and analyzes potential threats. • Autonomous driving: Semi-autonomous driving ability endows it with capacity to perform certain tasks without driver intervention. • Cybersecurity systems: Advanced cybersecurity measures protect electronics and communications systems. • 360 degrees situational awareness: Sensors, cameras and radars constantly monitoring tank's perimeter. • Automatic targeting and firing control: AI-supported targeting system automatically tracks targets and aims. • Commander assistance system: Provides AI-supported analysis to help commander in situational awareness and decision-making processes. • Crew training: In-vehicle simulation system for crew's training.
Jaguar UGV	•Weapon: Equipped with 7.62 mm MAG machine gun. • Sensors: High-resolution cameras and advanced comms systems allow constant observation of perimeter. • Energy management: Quiet operation thanks to electric engine.	• Autonomous driving: It spots and bypass obstacles and follows charted route. • Threat perception: Fitted with an AI-supported system to analyze potential threats in the perimeter. • Remote control: Can be remote-controlled by an operator if need arises. • Situational awareness: Constant surveillance of perimeter with sensors and cameras providing 360 degrees line of sight. • Can dock itself for charging.

IRIS UGV 	• Weight: 1,65 kgs • Dimensions: Length, 23 cms width, 20 cms • Modular design: Can be integrated with different sensors, cameras and comms systems based on mission and provides a flexible operational solution. • Compact and light: Easy to use in narrow spaces, underground tunnels and challenging remote points. • Camera: High-resolution cameras are fitted with 90 degrees incline and zoom features.	• Autonomous movement: Can autonomously move as AI-supported sensors help detecting obstacles; can reach destination on its own and return after completing the mission. • Decision support system: Can provide suggestions to operator by analyzing data collected during the mission. Makes reconnaissance and surveillance more sensitive with its ability to distinguish threats and objects • Mission flexibility: Fitted with tactical arms and hooks for operations in underground tunnels and narrow spaces. • Real-time data transfer: Increases efficiency of the operation through real-time video and audio data transfer.
Carmel Combat Vehicle 	• Its light structure allows swift movement and maneuvering in narrow spaces. • Crew capacity: Number of crew reduced to 2 to increase operational efficiency and optimize manpower. • Closed-hatch operation ability: This ability gives crew the option to run operation entirely from within, providing security and efficiency. • Modular weapon system: Can be fitted with various weapon systems. • Remote-controlled operations: Can be remote-controlled to ensure security of crew in risky operations.	•Situational awareness systems: Fitted with advanced sensors and cameras that can scan the environment 360 degrees; this provides the crew high situational awareness. • AI-supported target detection and assault: AI algorithms can autonomously perform target detection and assault missions. • Mission and threat analysis: Can run real-time data analysis in the battlefield, assess threats and make decisions. • Urban and asymmetric warfare: Optimized for use in narrow spaces and high-risk urban warfare. • Security in dangerous areas: Optimizes crew's security with its autonomous systems and closed-hatch operation ability.

Source: Compiled by authors from "Elbit System, Eurasian Times, Roboteam Reports, Army Recognition, Janes OSINT, Defence Procurement International" sources.

AI, INTERNATIONAL LAW AND ETHICS

Use of AI technologies in defense and offensive strategies led to landmark changes in understanding the modern warfare. This transformation was reflected in use of AI-supported military systems by Israel in operations against Palestine which played an active role in distinguishing the civilian and military targets, their analysis and in decision-making processes.

AI systems like Habsora and Lavender change the nature of warfare by accelerating target detection and making operations more devastating. However, these developments brought about significant debates in terms of international law and ethical principles. Military operations conducted via AI necessitated reassessment of basic principles of law of war including proportionality, distinction and military necessities. International humanitarian law dictates protection of civilians during the conflicts and absolute distinction of military targets whereas it is observed that Israel's AI-based systems openly and systematically violate these principles. Errors made by AI systems in target detection in civil-

ian areas cause wrongful targeting of civilians and have potential for serious human rights violations. Beyond this risk, attacks where Israel openly admitted to deliberate civilian casualties are under spotlight.

Unlike conventional warfare methods, AI-based systems provide a decision-making process where human intervention is minimized. Prevalent use of these technologies in Israel's military operations led to higher civilian casualties and intense criticism in terms of international humanitarian law. Definition of civilian casualties as "collateral damage" only adds to severity of those violations.

UN and human rights organizations report that Israel's attacks on civilians systematically violates law of war. These attacks constitute war crimes under international law of war which protect civilian population. The principle of military necessity legitimizes use of minimum force solely to reach the military target while the principle of proportionality dictates that the expected harm to civilians or civilian property, should not be excessive in relation to expected military advantage. These two principles aim to reduce war's humanitarian toll and protection of civilians. Yet, it is obvious that during the massive military operations carried out by deployment of AI systems by Israel against Palestine, these principles are violated.

Large-scale devastation strategies Israel often resorted to is assessed as disproportionate force under international legal norms. Civilian casualties and damage to infrastructure is disproportionate to obtained military advantages.

Violation of proportionality principle is obvious in Israel's attacks targeting Gaza. Attacks carried out in civilian-populated areas violate principle of distinction in law of war and this leads to serious violations that can amount to war crimes. Although AI systems can swiftly detect the target, room for error and reduction of human intervention in this process cause a rise in civilian casualties. This demonstrates that Israel disregards the principle of proportionality and openly violates international law by intensely using these systems in areas with high civilian population.

In conclusion, Israel seriously violates the principles of military necessity and proportionality in its attacks against Palestine and Gaza while AI systems contribute to massive devastation in this process. Use of these technologies under circumstances with limited human intervention and their

compliance with law of war stirred up debates and led to widespread criticism on an international level. Israel's attacks ignoring international law and human rights put debate on "technological determinism" and "responsibility" on the back burner. Israel's attacks violating international law and human rights are not confined to use of AI technologies and also contain widespread prevalence of human rights violations. According to Human Rights Watch reports, Israel's blockade on Gaza restricts civilians' access to food and basic amenities and the Tel Aviv administration commits war crimes by weaponizing the hunger.[103] This is a blatant violation of international humanitarian law. In the meantime, Israel's use of weapons like white phosphorus banned by international treaties in the battlefield, is regarded as another significant war crime.[104]

The fact of commitment of crimes under aforementioned concepts and who or which group of people would face criminal sanctions in this environment where Israel ignores international law should be debated. Technological determinism defines a scenario where technology itself has a determining role and human control is limited.[105] Israel's attacks through military AI systems are examples of this concept. Autonomous structure of systems like Habsora and Lavender in decision-making processes lead to technologies used in operations to make decisions by themselves without human intervention. This further complicates responsibility and accountability mechanisms. Technological determinism is an approach advocating that technology is primary factor guiding social structures, individual behaviors and cultural developments. According to this view, technological developments have an autonomous impact on communities and are driving force of social change. Human control is limited in this process. For instance, advanced technologies like AI bring about many innovations and changes in several fields like fields of health, law and education while scenarios where human control is dependent on technology are drafted. At the same time, international law has to adapt to these technological developments. Impact of AI in decision-making processes can require the laws to be reshaped.

103 "Report: Israel uses hunger in Gaza as a weapon of war", Euronews Turkish, December 18 2023.

104 "Report: Israel uses hunger in Gaza as a weapon of war".

105 "Technological Determinism", Clemson Open Textbooks, October 1 2024, https://opentextbooks.clemson.edu/sciencetechnologyandsociety/chapter/technological-determinism, (Date of Access: August 30 2024).

Attacks Israel carried out through military AI systems can be assessed as a concrete example of technological determinism concept. Exclusion of human intervention in distinction between civilian and military targets by autonomous systems like Habsora and Lavender or their approval of civilian casualties while striking a target complicate the concept of responsibility. The decisions made by AI systems caused those technologies to go beyond being a mere instrument and becoming an independent actor in the battlefield. This leads to a serious debate on who would be held responsible in war crimes committed during Israel's attacks. For this reason, the issue of responsibility emerges in case of an AI-supported attack that causes civilian casualties.

International law dictates a clear distinction between military and civilian targets and protection of civilians. However, lack of transparency in AI systems' decision-making processes and algorithmic prejudices challenge the application of these principles. It is difficult to foresee the extent of an attack conducted by fully autonomous AI systems determining targets on their own. This is because perception of threat for this system whose algorithm is based on learning new threats and their elimination can be shaped not only by developers of the system but also by outside dynamics they are not in control. It makes wholly correct prediction of behavior of such systems difficult.

Ethically, value of human life and humanitarian aspect of the war stand out. Ability of AI systems to make lethal decisions without human intervention can cause a disregard for ethical responsibility and conscious assessment. One of the most complicated issues in use of AI system is who will be responsible in case of possible violations. In conventional law of war, people directly issuing orders or those carrying out them are held responsible. But the autonomous nature of decision-making processes in AI systems blurs the chain of responsibility.

In this context, there are several possible sides that can be held responsible. Can software developers and engineers, people who designed and developed algorithms be held responsible for errors of the system or its prejudice? To what extent the military chain of command, high-ranking officials who authorize use of AI systems and make operational decisions can be held responsible? To what extent the officials of state and government, governments drafting national security policies and approving employment of those technologies are responsible for actions against international law?

International law has no clear answers for those questions. Therefore, international community should develop a joint effort for regulating the use of AI-based weapons systems and to prevent human rights violations. UN and other international bodies should create new treaties and protocols tackling ethical and legal aspects of those technologies.

Eventually, deployment of AI-based systems leads to two issues: i) compliance of deployment of those systems to ethics and international law, ii) whose responsibility it will be in case of likely violations. On December 29, 2023, South Africa formally filed a lawsuit against Israel citing that Israel contravened the Convention on the Prevention and Punishment of the Crime of Genocide. South Africa raised attention to Israel's attacks on civilians particularly in Gaza, noting that those attacks are as widespread and systematic as to amount to genocide. In this lawsuit, South Africa presents many documents to prove that Israel had intention to eradicate "national, ethnical and racial" group in attacks against Palestinians. Türkiye, a party to the lawsuit, also presents a myriad of documents to support these charges. This lawsuit is closely associated with civilian casualties caused by deployment of Habsora and similar AI systems. To what extent the developers of this system, decision-making and commanding authorities and government officials will be charged in case of a guilty verdict for Israel?

Devastation and suffering are natural in warfare but it can deepen with deployment of AI systems by states like Israel which ignores the law. Therefore, the technology should be developed in compliance with ethical principles and applied thus. Ethical and legal problems stemming from deployment of AI-based systems made waves in the international community and led to launch of several initiatives in this field. For instance, an international initiative called Campaign to Stop Killer Robots which was launched in 2013, makes a call for a ban on development, production and deployment of fully autonomous weapons systems.[106] This campaign is supported by a wide-ranging coalition composed of civic society organizations, human rights associations, academics and technology experts.

At this point, some states and international bodies advocate a ban on autonomous weapon systems or tighter inspection of those systems while

106 "Campaign to Stop Killer Robots Launches", Stop Killer Robots, April 9 2013, https://www.stopkillerrobots.org/news/campaign-launch, (Date of Access: October 1 2024).

others oppose the restrictions, highlighting their military advantages. These different viewpoints complicate the process of an update on international law and delay or prevent creation of possible solutions.

CONCLUSION

When how Israel utilized AI technologies in military tactics and strategies and its impact on international law, ethics and nature of the warfare -especially through integration of AI in defense and attack systems- are examined, it is observed that it led to a significant change in modern warfare technologies. Defense systems like Iron Dome analyzes data from radars and sensors and automatically detect an eliminate threats. In addition, systems like Habsora and Lavender determine targets in Palestine, minimize human intervention and makes Israel's assault operations more effective. Nevertheless, these technologies cause serious human rights violations such as indiscriminate strikes against civilian targets.

Deployment of AI in modern warfare covers a wide spectrum from decision support systems to UAVs and efficiency of autonomous systems stand out. Automation level of systems like Habsora and Lavender limits human intervention and increases civilian casualties. Although Israel gains military advantage by deployment of those technologies while disregarding civilian casualties, these facts highlight that AI should be developed within ethical and legal limits and utilized such.

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REPORT

DEADLY ALGORITHMS
Destructive Role of Artificial Intelligence in Gaza War

SİBEL DÜZ, MUHAMMED SEFA KOÇAKOĞLU

Israel has been enhancing its military capabilities by extensively using AI technologies in both defense and offensive operations. Defense systems like the Iron Dome use AI-supported radars to detect and intercept missile threats automatically, thereby minimizing human intervention and increasing operational efficiency. Similarly, AI-based offensive systems such as Habsora and Lavender offer autonomous functionalities by eliminating human involvement in target detection and attack planning. However, the employment of these technologies in civilian areas has resulted in substantial civilian casualties, and open sources provide substantial evidence that Israel has violated international law during these military operations.

Especially after October 7, 2023, Israel has heavily deployed AI technologies in its large-scale attacks on Palestine. During these operations, the acceptance of civilian casualties as "collateral damage" and the disregard for civilian areas in target identification violate the fundamental principles of international humanitarian law. The ethical and legal dimensions of Israel's AI-supported attacks harming civilians have been criticized by human rights organizations and the international community.The destructive effects of these AI-powered operations on the civilian population further exacerbate human rights violations.

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